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EDWIN DUNKIN, ESQ., F.R.S., Vice-President, in the Chair.

The Rev. F. B. Allison, M.A., Grammar School, Chesterfield;

Benjamin Francis Cobb, Esq., 79 Cornhill, E.C., and 148, Cornwall Road, W.; and

Henry Augustus Severn, Esq., 79 Earl's Court Road, Kensington, W., and Devalah, Madras, India,

were balloted for, and duly elected Fellows of the Society.

Comparison of the Observations of the Sun made at Washington, 1866–1875, with Hansen's Tables. By Dr. C. R. Powalky.

Explanation of the method used, and the meaning of the notation. Let $z_1, z_2 \ldots z_n$ be the arithmetical means of C.—O. for each month in the different years; $n_1, n_2 \ldots n_n$ the number of observations compared; Σ the sum of the squares of the residuals for each set; $w_1, w_2 \ldots w_n$ the weights; then for the first approximation Z is found by putting :—

$$w_1 = \frac{n_1(n_1-1)}{\Sigma_1 + n_1(Z-z_1)^2},\ w_2 = \frac{n_2(n_2-1)}{\Sigma_2 + n_2(Z-z_2)^2} \ldots .$$

$$Z = \frac{w_1z_1 + w_2z_2 + \ldots + w_nz_n}{w_1 + w_2 + \ldots + w_n}, \text{ and } W = w_1 + w_2 + \ldots w_n \text{ by } \textit{indirect} \text{ way.}$$

I. Declination.

Example for January.

Years.	Date.	n	z	Σ	Mean Error.
			"		"
1866	Jan. 8	5	+1·40	5·6	±0·28
1867	22	20	+0·57	23·9	±0·06
1869	23	8	−0·80	18·6	±0·33
1872	22	12	−1·60	40·8	±0·31
1873	26	2	−0·80	3·9	±1·96
1874	18	7	+0·67	35·7	±0·85
1875	18	5	+0·68	4·5	±0·22

Jan. 20·0 $Z = +0''.45$ $W = 28·3$

See the values of z, Σv^2 and n in 'Detailed Calculations for the Declinations.'

In this way the following results were found for the first approximation (see details in the second approximation) :—

Jan. 20·0	$Z = +0''.45$	$W = 28·3$
Febr. 16·5	+0·03	37·8
Mar. 20·0	−0·17	57·5
Apr. 18·9	+0·22	96·0
May 17·4	+0·20	94·0
June 20·0	+0·29	73·0
July 17·0	+0·67	99·0
Aug. 14·6	+0·66	73·0
Sept. 17·3	+1·14	48·0
Oct. 17·1	+0·96	59·4
Nov. 13·7	+0·75	48·0
Dec. 13·6	+0·75	43·0

From these I formed twelve equations for determining :—

$d\phi'$ . . . . a constant, to be applied with contrary sign to the observations ($-d\phi'$ . . . . a correction of latitude or zenith-point assumed in the Volumes).

dl . . . . correction of the equinoctial point in the Solar Tables.

$d\omega$ . . . . " " obliquity of the ecliptic " "

dM and de (M the longitude of perihelion, e excentricity of the

orbit) remain here indeterminate, to be determined further on by means of the Right Ascensions.

The solution gives:—

$$\left.\begin{aligned} dl &= +1''.140 - 0.797\, dM - 0.04\, de \ldots . \quad W = 61 \\ d\omega &= +0.09 + 0.001\, dM + 0.03\, de \ldots . \quad 321 \\ d\phi' &= -0.489 + 0.000\, dM - 0.11\, de \ldots . \quad 663 \end{aligned}\right\} \text{II.}$$

N.B.—The value of *de* becomes very small and *dM* very uncertain, in consequence of the different systems of fundamental Star-places, 1866–1869 and 1870–1875, and the respectively small number of observations in these two intervals.

Assuming $dM=0$, $de=0$, I found by computation from the above solution the values for *z* and the residuals (C.—O.), as in the following scheme:—

Jan. 20·0;	*z* (observed) =	+0″·45;	*z* (computed) =	+0″·32;	Resid. =	+0″·13
Feb. 16·5	„	+0·03	„	+0·14	„	−0·11
Mar. 20·0	„	−0·17	„	+0·04	„	−0·21

&c., &c.

Taking for *second approximation* the computed values of *z* from II. as the correct ones and determining anew their weights, then denoting the observed values by *z* and the computed corrections by *z'*, I found now *directly* (as seen in the 'Detailed Calculation for the Declinations') these new values of *z*:—

Date.	*z*	*z'*	R.	W.
Jan. 20·4	+0″·41	−0″·32	+0·09	26·1
Feb. 16·4	+0·24	−0·14	+0·10	48·2
Mar. 20·0	−0·05	−0·04	−0·09	54·3
Apr. 19·2	+0·15	−0·06	+0·09	99·6
May 17·3	+0·21	−0·17	+0·04	95·7
June 20·1	+0·30	−0·41	−0·11	71·7
July 17·4	+0·67	−0·62	+0·05	97·1
Aug. 14·9	+0·68	−0·81	−0·13	74·3
Sept. 18·9	+1·04	−0·88	+0·16	39·2
Oct. 17·1	+0·94	−0·96	−0·02	60·9
Nov. 13·5	+0·76	−0·87	−0·11	47·2
Dec. 12·7	+0·60	−0·65	−0·05	43·1

I consider a new solution for a more accurate determination of $d\phi'$, dl, and $d\omega$ unnecessary, the values from the first solution, as shown by the residuals, agreeing quite satisfactorily.

As to the Declinations, I was compelled to adopt this method, viz., of combining the sets from arithmetical means of each year, because the elements of reduction (division and flexure of the circle) were altered each year. As to the Right Ascensions (compare *Astron. Nachr.* No. 2105) :—

'An essential condition for determining the elliptical elements of the Sun's orbit is an accurate determination of the differences of R.A. of the Stars from which the R.A. of the Sun is derived.'

Here we have two systems of fundamental stars, one used for the R.A. of the Sun from 1866–1869, the other for the R.A. 1870–1875, which therefore we must treat separately. We have more observations of the Sun's R.A. from 1866 to 1869, and their successive series of sets agree far better than those from 1870 to 1875. I was at liberty to unite the differences (C.—O.) for periodical intervals of twenty-three consecutive days of the year, regardless of their occurrence within a single year, by arithmetical means; but I adopted the same method and process as with the Declinations—namely, that of approximation. Finally I saw that in regard to results it would be nearly indifferent which of the methods was employed; only in regard to weights (the unity of weight is here taken as $0^{s}\cdot1$) some difference is perceptible.

The solution for determining $\Delta a'$ (a constant correction of all fundamental Star-places), ΔM and $\Delta\omega$, shows the coefficients of $\Delta a'$ and ΔM, in consequence of the small number of observations in both systems, so nearly equal that, as $\Delta a'$, the value of ΔM, and consequently also the value of dl from declinations, however certain may be the numerical value in

$$\Delta l = +1''\cdot140 - 0\cdot797\Delta M$$

fails to give an indisputable decision.*

II. Right Ascension, 1866–1869,

with corrections for perturbations by ♀, ♂, ♃, taking for m' (♀) Le Verrier's value, or $m'=0\cdot00000250$ (instead of $0\cdot00000245$), for m''' Hall's value, and for m^{iv} Bessel's; for nutation Peters-Nyren's.

Originally I intended to determine, besides the elements of the Sun's orbit, and especially the equinoctial point, the mass of ♀ from observations in Washington with the Transit-Circle from 1862–1880; but this would require a totally new reduction in R.A., founded on a single system of fundamental star-places.

The following comparisons in means, and the results from them, can therefore only be regarded as a preliminary task to show the insufficiency of the hitherto adopted reductions in R.A.

Denoting by z the value of Δa (C.—O.) in arc, from the

* The sentence is printed as it stands in the MS.; as are also the symbols d, Δ, and the accented and unaccented letters a, a', ϕ, ϕ'.—Ed.

method of approximation by weights (by combining arithmetical means for each year), by z', the values of Δa (C.—O.) from purely arithmetical mean, we find :—

1)	Jan. 14·0	$z = -0''.795$	W = 11·5	. . . .	Jan. 12	$z' = -0''.585$	$n = 16$
2)	Jan. 30·7	−0·645	26		Feb. 3	−0·420	28
3)	Feb. 18·6	−0·540	46		„ 19	−0·135	31
4)	Mar. 16·1	−0·285	43		Mar. 15	−0·300	28
5)	Apr. 4·4	−0·150	69		Apr. 4	−0·060	32
6)	„ 28·3	−0·060	31		„ 28	+0·075	38
7)	May 21·1	−0·330	90		May 21	−0·450	39
8)	June 14·9	−0·495	65		June 15	−0·450	38
9)	July 9·4	−0·360	71		July 10	−0·300	39
10)	Aug. 1·0	−0·180	100		Aug. 1	−0·405	31
11)	„ 22·8	−0·450	46		„ 22	−0·450	30
12)	Sept. 12·5	−0·345	36		Sept. 13	−0·345	22
13)	Oct. 8·0	−0·120	133		Oct. 8	−0·150	27
14)	Nov. 0·7	−0·030	72		Nov. 1	−0·300	37
15)	„ 25·2	−0·825	38		„ 26	−0·825	25
16)	Dec. 18·4	−0·990	30		Dec. 18	−1·065	21

From the sixteen equations with z and W, I obtained :—

$$\left.\begin{aligned} \Delta M &= +1''.587 - 1\cdot005\,dl - 0\cdot22\,de \;\ldots\; W^* = 2\cdot9 \\ \Delta\omega &= +0\cdot105 + 0\cdot002\,dl + 0\cdot005\,de \;\ldots\; W = 429 \\ \Delta a' &= -1\cdot235 + 0\cdot015\,dl + 0\cdot23\,de \;\ldots\; W = 2\cdot4 \end{aligned}\right\} \text{III.}$$

By II. (Declin.) and III. (R.A.) connected,

$\Delta\phi = +0''.50$ (correction of zenith point)
$\Delta\omega = +0\cdot09$
$\Delta e = +0\cdot10$

and very uncertain,

$\Delta M = +1''.23$
$\Delta l = +0\cdot15$
$\Delta a = +1\cdot23$ (correction of R.A. of comparison stars).

* Unity of W = 0·1 = 1·5″.

Detailed Calculation for the Declinations.

Second Approximation. *The Years* 1866–1875 *denoted by* 1–10, *the Date of the Month by* t; $\Sigma v^2 + n(Z-z)^2$ *by* Σ'.

(January, $Z = +0''.32$, from computation in the first approximation.)

								Logarithms			Numbers		
Year.	t	z	Σv^2	n	$Z-z$	$n(Z-z)^2$	$n.(n-1)$	Σ'	z	w	t	zw	w	tw
1	8	$+1''.36$	5·6	5	1·04	5·4	1·301	1·041	0·134	0·260	0·903	+ 2·5	1·8	15
2	22	+0·57	23·9	20	0·25	1·3	2·580	1·401	9·756	1·179	1·342	+ 8·6	15·1	332
4	23	−0·79	18·6	8	1·11	9·9	1·748	1·455	9·898	0·293	1·362	− 1·6	2·0	45
7	22	−1·56	40·8	12	1·78	38·0	2·121	1·897	0·193	0·224	1·342	− 2·6	1·7	37
8	26	+0·80	3·9	2	0·48	0·5	0·301	0·643	9·903	9·658	1·415	+ 0·4	0·5	12
9	18	+0·67	35·7	7	0·35	0·9	1·623	1·564	9·826	0·059	1·255	+ 0·8	1·1	21
10	18	+0·68	4·5	5	0·36	0·7	1·301	0·712	9·833	0·589	1·255	+ 2·6	3·9	70
											Sum	+10·7	26·1	532
											Logar.	1·029	1·417	2·726

Jan. 20·4, $z = +0''.41$, $W = 26''.1$.

(February, Z = +0″·14)

Year.	t	z	Σv^2	n	Z−z	n(Z−z)^2	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	t	Numbers zw	Numbers w	tw
1	16	+0·70	12·5	15	0·56	4·7	2·322	1·235	9·845	1·087	1·204	+ 8·5	12·2	195
2	14	+0·32	11·2	11	0·18	0·4	2·041	1·065	9·505	0·976	1·146	+ 3·0	9·5	132
3	17	−0·17	22·7	8	0·31	0·8	1·748	1·371	9·230	0·377	1·230	− 0·4	2·4	40
4	19	+0·22	12·7	13	0·08	0·1	2·193	1·107	9·342	1·086	1·279	+ 2·7	12·2	232
5	17	−1·34	14·2	9	1·48	19·7	1·857	1·530	0·127	0·327	1·200	− 2·8	2·1	36
7	13	−0·50	1·8	4	0·64	1·6	1·079	0·532	9·699	0·547	1·114	− 1·8	3·5	46
8	10	{−1·1	—	1}	rejected									
9	18	−0·18	10·9	8	0·32	0·8	1·748	1·068	9·255	0·680	1·255	− 0·9	4·8	86
10	15	+1·01	16·1	6	0·87	4·5	1·477	1·314	0·004	0·163	1·176	+ 1·5	1·5	22
											Sum	+11·8	48·2	789
											Logar.	1·072	1·683	2·897

Febr. 16·4, z = +0·24, W = 48·2.

(March, Z = +0″·04)

Year.	t	z	Σv^2	n	Z−z	n(Z−z)^2	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	Logarithms t	Numbers zw	Numbers w	Numbers tw
1	19·1	−0″·06	6·3	10	0·10	0·1	1·954	0·806	8·778	1·148	1·281	− 0·85	14·1	268
2	25·8	+1·06	3·5	11	1·02	11·4	2·041	1·173	0·025	0·868	1·412	+ 7·81	7·4	190
3	24·4	−1·70	1·4	5	1·74	15·1	1·301	1·218	0·230	0·083	1·387	− 2·05	1·0	30
4	17·0	−0·25	18·3	17	0·29	1·4	2·435	1·295	9·398	1·140	1·230	− 3·45	13·8	234
5	Great deviations, the rejection has no influence on the result.													
7	24·5	−0·46	1·7	4	0·50	1·0	1·079	0·431	9·663	0·648	1·389	− 2·05	4·4	109
8	19·0	−0·41	6·0	9	0·45	1·8	1·857	0·892	9·613	0·965	1·279	− 3·78	9·2	175
9	20·8	−0·55	4·1	4	0·59	1·4	1·079	0·740	9·740	0·339	1·318	− 1·20	2·2	46
10	15·5	+1·34	11·2	8	1·30	13·5	1·748	1·410	0·127	0·338	1·190	+ 2·92	2·2	33
											Sum	− 2·55	54·3	1·085
											Logar.	0·407	1·735	3·035

March 20·0, z = −0·05, W = 54·3.

(April, Z = +0″·06)

Year.	t	z	Σv^2	n	Z−z	n(Z−z)^2	$n.(n-1)$	Σ'	Logarithms x	w	t	Numbers zw	w	tw
1	17·8	+0″·77	9·8	14	0·71	7·1	2·260	1·228	9·886	1·032	1·250	+ 8·28	10·8	192
2	14·0	+0·90	20·6	22	0·84	14·9	2·665	1·550	9·954	1·115	1·146	+11·72	13·0	182
3	21·5	−0·06	2·4	12	0·12	0·2	2·121	0·415	8·778	1·706	1·332	− 3·05	50·8	1092
4	19·8	−0·52	16·4	9	0·58	3·0	1·857	1·288	9·716	0·569	1·297	− 1·94	3·7	73
5	15·9	−0·41	5·8	8	0·47	1·8	1·748	0·881	9·613	0·867	1·201	− 3·02	7·4	117
7	18·1	−0·51	5·2	6	0·57	2·0	1·477	0·857	9·708	0·620	1·258	− 2·13	4·2	75
9	18·8	+0·52	0·8	4	0·46	0·9	1·079	0·230	9·716	0·849	1·274	+ 3·67	7·0	133
10	16·4	+0·54	6·1	5	0·48	1·3	1·301	0·869	9·732	0·432	1·215	+ 1·46	2·7	44
											Sum	+14·99	99·6	1908
											Logar.	1·176	1·998	3·281

April 19·2, z = +0″·15, W = 99·6.

(May, Z = +0″·18)

Year.	t	z	Σv^2	n	Z−z	n(Z−z)²	$n.(n-1)$	Σ′	Logarithms z	w	t	Numbers zw	w	tw
1	15·4	+0·16	7·9	18	0·01	0·0	2·486	0·898	9·204	1·588	1·188	+ 6·2	38·7	597
2	20·0	+1·17	20·9	17	1·00	17·0	2·435	1·579	0·068	0·856	1·301	+ 8·4	7·2	144
3	19·0	+0·18	16·6	18	0·01	0·0	2·486	1·220	9·255	1·266	1·279	+ 3·3	18·4	351
4	17·8	−0·26	24·8	17	0·43	3·1	2·435	1·446	9·415	0·989	1·250	− 2·5	9·7	173
5	13·3	−0·13	19·7	11	0·30	0·9	2·041	1·314	9·114	0·727	1.124	− 0·7	5·3	71
7	14·1	−0·74	15·2	11	0·91	9·1	2·041	1·386	9·869	0·655	1·149	− 3·3	4·5	64
8	20·0	+0·70	3·9	4	0·53	1·1	1·079	0·699	9·845	0·380	1·301	+ 1·7	2·4	48
9	25·1	+0·39	8·8	7	0·22	0·3	1·623	0·959	9·591	0·664	1·400	+ 1·8	4·6	116
10	19·5	+1·12	19·9	13	0·95	11·7	2·193	1·500	0·049	0·693	1·290	+ 5·5	4·9	96
											Sum	+20·4	95·7	1660
											Logar.	1·300	1·981	3·220

May 17·3, z = +0·21, W = 95·7.

(June, $Z = +0''.40$)

Year.	t	z	Σv^2	n	$Z-z$	$n(Z-z)^2$	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	t	Numbers zw	Numbers w	Numbers tw
1	17·3	$+0''.64$	22·8	20	0·24	1·2	2·580	1·380	9·806	1·200	1·238	+ 10·1	15·8	274
2	21·5	+0·16	13·7	15	0·24	0·9	2·322	1·164	9·204	1·158	1·332	+ 2·3	14·4	309
3	22·0	+0·10	18·5	16	0·30	1·3	2·380	1·297	9·000	1·083	1·342	+ 1·2	12·1	266
5	22·4	+0·26	12·3	14	0·14	0·3	2·260	1·100	9·415	1·160	1·350	+ 3·8	14·4	324
7	22·1	−0·24	7·5	8	0·64	3·3	1·748	1·033	9·380	0·718	1·344	− 1·2	5·2	114
8	10·4	+0·54	25·5	10	0·14	0·2	1·954	1·410	9·732	0·544	1·017	+ 1·9	3·5	36
9	18·2	+0·13	14·9	9	0·27	0·7	1·857	1·193	9·114	0·664	1·260	+ 0·6	4·6	84
10	19·2	+1·80	16·9	8	1·40	15·7	1·748	1·513	0·255	0·235	1·283	+ 3·1	1·7	33
											Sum	+21·8	71·7	1440
											Logar.	1·338	1·853	3·158

June 20·1, $z = +0''.30$, $W = 71·7$

(July, Z = +0″·62)

Year.	t	z	Σv^2	n	Z−z	$n(Z-z)^2$	$n_s(n-1)$	Σ'	Logarithms z	w	t	Numbers zw	w	tw
1	16·2	+0′·45	8·6	17	0·17	0·5	2·435	0·959	9·653	1·476	1·210	+13·5	29·9	485
2	20·3	+1·15	14·7	23	0·53	6·5	2·704	1·326	0·061	1·378	1·308	+27·5	23·9	485
3	14·7	+0·42	18·6	15	0·20	0·6	2·322	1·283	9·623	1·039	1·167	+ 4·6	10·9	161
5	18·5	+0·36	34·1	14	0·26	1·0	2·260	1·545	9·556	0·715	1·267	+ 1·9	5·2	96
7	17·0	+0·96	3·5	8	0·34	0·9	1·748	0·644	9·982	1·104	1·230	+12·2	12·7	216
8	20·0	+0·54	18·0	9	0·08	0·06	1·857	1·257	9·732	0·600	1·301	+ 2·2	4·0	80
9	16·0	+0·32	1·6	5	0·30	0·45	1·301	0·312	9·505	0·989	1·204	+ 3·1	9·8	156
10	13·5	+0·80	2·9	2	0·18	0·07	0·301	0·473	9·903	4·828	1·130	+ 0·5	0·7	9
											Sum	+65·5	97·1	1688
											Logar.	1·816	1·987	3·227

July 17·4, z = +0·67, W = 97·1

(August Z = +0″·81)

Year.	t	z	Σv^2	n	Z−z	$n(Z-z)^2$	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	t	Numbers zw	Numbers w	Numbers tw
1	18·0	+0″·90	16·4	17	0·09	0·1	2·435	1·218	9·954	1·217	1·255	+14·8	16·5	296
2	17·5	+0·72	15·4	22	0·09	0·2	2·665	1·192	9·857	1·473	1·243	+21·4	29·7	520
3	Rejected for 2 or 3 great discrepancies among 7 observ.													
5	4·6	+0·57	3·6	8	0·24	0·5	1·748	0·613	9·756	0·135	0·663	+ 7·8	13·6	63
6	15·2	+0·37	22·7	9	0·44	1·8	1·857	1·389	9·568	0·468	1·182	+ 1·1	2·9	45
7	11·0	−1·00	2·1	4	1·81	13·1	1·079	1·185	0·000	9·894	1·041	− 0·8	0·8	9
8	13·8	+0·15	7·6	6	0·66	2·6	1·477	1·013	9·176	0·464	1·140	+ 0·4	2·9	40
9	13·3	+0·07	7·8	3	0·74	1·7	0·778	0·978	8·845	9·800	1·124	0·0	0·6	8
10	16·7	+0·80	9·8	9	0·01	0·0	1·857	0·991	9·903	0·866	1·223	+ 5·9	7·3	123
											Sum	+50·6	74·3	1104
											Logar.	1·704	1·871	3·043

August 14·9, z = +0·68, W = 74·3.

(September, Z = +0″·94)

Year.	t	z	Σv^2	n	Z−z	$n(Z-z)^2$	$n,(n-1)$	Σ'	Logarithms z	Logarithms w		Numbers zw	Numbers w	Numbers tw
1	20·0	+1″·59	17·0	11	0·65	4·6	2·041	1·335	0·201	0·706	1·301	+ 8·1	5·1	102
2	16·6	+1·20	17·1	16	0·26	1·1	2·380	1·260	0·079	1·120	1·220	+15·8	13·2	219
3	14·7	+0·76	20·2	11	0·18	0·4	2·041	1·314	9·881	0·727	1·167	+ 4·1	5·3	78
6	Rejected 3 observs., compare Washington Observ. Volume for 1871.													
7	28·0	+0·70	0·6	3	0·24	0·2	0·778	9·903	9·845	0·875	1·447	+ 5·3	7·5	210
8	20·1	+0·74	14·1	7	0·20	0·3	1·623	1·158	9·869	0·465	1·303	+ 2·2	2·9	59
9	22·7	−0·96	15·3	7	1·90	25·3	1·623	1·609	9·982	0·014	1·356	− 1·0	1·0	24
10	11·5	+1·53	14·0	9	0·59	3·1	1·857	1·233	0·185	0·624	1·061	+ 6·4	4·2	48
											Sum	+40·9	39·2	740
											Logar.	1·612	1·593	2·869

September 18·9, z = +1·04, W = 39·2

(October, Z = +0″·95)

									Logarithms			Numbers		
Year.	t	z	Σv^2	n	Z−z	$n(Z-z)^2$	$n.(n-1)$	Σ	z	w	t	zw	w	tw
1	15·2	+0″·93	5·9	11	0·02	0·0	2·041	0·771	9·968	1·270	1·182	+17·3	18·6	283
2	18·0	+0·91	9·0	14	0·04	0·2	2·260	0·964	9·959	1·296	1·255	+18·0	19·8	356
3	18·2	+1·44	24·9	14	0·49	3·4	2·260	1·452	0·161	0·808	1·260	+ 9·3	6·4	117
7	19·5	+1·00	5·1	2	0·05	0·0	0·301	0·708	0·000	9·593	1·290	+ 0·4	0·4	8
8	18·2	+1·16	6·7	8	0·21	0·4	1·748	0·851	0·065	0·897	1·260	+ 9·2	7·9	144
10	17·0	+0·50	17·5	13	0·45	2·6	2·193	1·303	0·699	0·890	1·230	+ 3·9	7·8	132
											Sum	+57·1	60·9	1040
											Logar.	1·757	1·785	3·017

October 17·1, z = +0·94, W = 60·9

(November, $Z = +0''.87$)

Year.	t	z	Σv^2	n	$Z-z$	$n(Z-z)^2$	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	t	Numbers zw	Numbers w	tw
1	11·3	+1·13	14·5	13	0·26	0·9	2·193	1·188	0·053	1·005	1·053	+11·4	10·1	114
2	15·8	+0·80	25·3	17	0·07	0·1	2·435	1·408	9·903	1·027	1·199	+ 8·5	10·6	168
3	13·5	+0·66	25·3	12	0·23	0·6	2·121	1·413	9·820	0·708	1·130	+ 3·4	5·1	69
7	14·7	+0·29	4·3	7	0·58	2·4	1·623	0·826	9·462	0·797	1·167	+ 1·8	6·3	92
8	8·9	+1·30	9·4	8	0·43	1·5	1·748	1·037	0·114	0·711	0·949	+ 6·7	5·1	46
9	17·3	0·00	15·2	9	0·87	6·8	1·857	1·342	$-\infty$	0·515	1·238	0·0	3·3	57
10	13·8	+0·62	10·2	9	0·25	0·6	1·857	1·033	9·792	0·824	1·140	+ 4·1	6·7	92
											Sum	+35·9	47·2	638
											Logar.	1·555	1·674	2·805

November 13·5, $z = +8''.76$, $W = 47·2$

(December, $Z = +0''.67$),

Year.	t	z	Σv^2	n	$Z-z$	$n(Z-z)^2$	$n.(n-1)$	Σ'	Logarithms z	Logarithms w	1	Numbers zw	Numbers w	
1	10·7	+0″·20	4·2	12	0·47	2·5	2·121	0·826	9·301	1·295	1·029	+ 3·9	19·7	211
2	14·7	+1·33	15·8	12	0·66	5·2	2·121	1·322	0·124	0·799	1·167	+ 8·4	6·3	92
3	13·9	+0·94	6·9	10	0·27	0·7	1·954	0·881	9·973	1·073	1·143	+11·0	11·8	164
6*	11·0	−0·70	9·6	2	1·37	3·8	0·301	1·127	9·845	9·174	1·041	− 0·1	0·1	2
7	8·3	−1·85	41·9	6	2·52	38·1	1·477	1·903	0·267	9·574	0·919	− 0·7	0·4	3
8	19·0	+3·03	61·3	7	2·36	39·0	1·623	2·001	0·481	9·622	1·279	+ 1·3	0·4	8
9	12·4	0·00	23·5	9	0·67	4·0	1·857	1·439	− ∞	0·418	1·093	0·0	2·6	32
10	18·2	+1·05	15·4	6	0·38	0·9	1·477	1·212	0·021	0·265	1·260	+ 1·9	1·8	34
											Sum	+25·7	43·1	546
											Logar.	1·410	1·634	2·737

December 12·7, $z = +0''.60$, $W = 43''.1$

* N.B. Rejected only one observation in Dec. 1871, Dec. 27, C.—O. $= -21''.4$: great deviations in 1872 and 1873.

Washington, 29 Sept. 1880.

Addition to a Paper on the Method of Least Squares (vol. xl. pp. 600–614). By J. W. L. Glaisher, M.A., F.R.S.

§ 27. The expressions given in § 14 for ε_x^2, ε_y^2, &c., the squares of the mean errors of x_o, y_o, &c., admit of being transformed by means of the following theorem :—

If D denote any determinant, and if $\mathrm{D}_{m,p}$ denote the determinant formed from it by omitting the m^{th} column and the p^{th} row, and if $\mathrm{D}_{mn,pq}$ denote that formed by omitting the m^{th} and n^{th} columns and the p^{th} and q^{th} rows, then

$$\mathrm{D}\mathrm{D}_{mn,pq} = \mathrm{D}_{m,p}\,\mathrm{D}_{n,q} - \mathrm{D}_{m,q}\,\mathrm{D}_{n,p}.$$

Applying the theorem to the numerator of ε_x^2, and taking the m^{th} and n^{th} columns to be the first and last, and the p^{th} and q^{th} rows to be the first and last, we obtain the formula

$$\begin{vmatrix} (bb), (bc), \dots (bf) \\ (cb), (cc), \dots (cf) \\ \dots\dots\dots \\ (fb), (fc), \dots (ff) \end{vmatrix} \begin{vmatrix} (aa), (ab), \dots (af)\ (an) \\ (ba), (bb), \dots (bf), (bn) \\ \dots\dots\dots\dots \\ (fa), (fb), \dots (ff), (fn) \\ (na), (nb), \dots (nf), (nn) \end{vmatrix}$$

$$= \begin{vmatrix} (aa), (ab), \dots (af) \\ (ba), (bb), \dots (bf) \\ \dots\dots\dots \\ (fa), (fb), \dots (ff) \end{vmatrix} \begin{vmatrix} (bb), \dots (bf), (bn) \\ \dots\dots\dots \\ (fb), \dots (ff), (fn) \\ (nb), \dots (nf), (nn) \end{vmatrix}$$

$$- \begin{vmatrix} (ba), (bb), \dots (bf) \\ \dots\dots\dots \\ (fa), (fb), \dots (ff) \\ (na), (nb), \dots (nf) \end{vmatrix} \begin{vmatrix} (ab), \dots (af), (an) \\ (bb), \dots (bf), (bn) \\ \dots\dots\dots \\ (fb), \dots (ff), (fn) \end{vmatrix},$$

in which the product of two determinants of $\mu-1$ and $\mu+1$ rows respectively is equated to the difference of the products of pairs of determinants each of which contains μ rows.

The value of $(m-\mu)\varepsilon_x^2$ may therefore be written

$$\frac{\begin{vmatrix} (bb), \dots (bf), (bn) \\ \dots\dots\dots \\ (fb), \dots (ff), (fn) \\ (nb), \dots (nf), (nn) \end{vmatrix} \begin{vmatrix} (ab), \dots (af), (an) \\ (bb), \dots (bf), (bn) \\ \dots\dots\dots \\ (fb), \dots (ff), (fn) \end{vmatrix}^2}{\begin{vmatrix} (aa), (ab), \dots (af) \\ (ba), (bb), \dots (bf) \\ \dots\dots\dots \\ (fa), (fb), \dots (ff) \end{vmatrix} \begin{vmatrix} (aa), (ab), \dots (af) \\ (ba), (bb), \dots (bf) \\ \dots\dots\dots \\ (fa), (fb), \dots (ff) \end{vmatrix}^2},$$

the second term of which is the value of x_o^2.

The first term may be written

$$\frac{\begin{vmatrix} (an), & (ab), \ldots & (af) \\ (bn), & (bb), \ldots & (bf) \\ \cdot & \cdot \cdot \cdot & \cdot \\ (fn), & (fb), \ldots & (ff) \end{vmatrix} \cdot \begin{vmatrix} (nn), & (nb), \ldots & (nf) \\ (bn), & (bb), \ldots & (bf) \\ \cdot & \cdot \cdot \cdot & \cdot \\ (fn), & (fb), \ldots & (ff) \end{vmatrix}}{\begin{vmatrix} (aa), & (ab), \ldots & (af) \\ (ba), & (bb), \ldots & (bf) \\ \cdot & \cdot \cdot \cdot & \cdot \\ (fa), & (fb), \ldots & (ff) \end{vmatrix} \cdot \begin{vmatrix} (na), & (nb), \ldots & (nf) \\ (ba), & (bb), \ldots & (bf) \\ \cdot & \cdot \cdot \cdot & \cdot \\ (fa), & (fb), \ldots & (ff) \end{vmatrix}},$$

and therefore is equal to $x_0\xi$, where ξ is the value of x given by the equations

$$\left.\begin{aligned} (na)x + (nb)y \ldots + (nf)t &= (nn), \\ (ba)x + (bb)y \ldots + (bf)t &= (bn), \\ \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ (fa)x + (fb)y \ldots + (ff)t &= (fn), \end{aligned}\right\}$$

§ 28. Thus we see that

$$\epsilon_x^2 = \frac{x_0(\xi - x_0)}{m - \mu},$$

$$\epsilon_y^2 = \frac{y_0(\eta - y_0)}{m - \mu},$$

$$\epsilon_z^2 = \&c.,$$

where x_0, y_0, . . . are the most probable values of x, y, . . . , given by the normal equations, and ξ, η, ζ, . . . are the values of x, y, z, . . . given by the respective systems of equations,
for ξ

$$\left.\begin{aligned} (na)x + (nb)y \ldots + (nf)t &= (nn), \\ (ba)x + (bb)y \ldots + (bf)t &= (bn), \\ \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ (fa)x + (fb)y \ldots + (ff)t &= (fn), \end{aligned}\right\},$$

for η,

$$\left.\begin{aligned} (aa)x + (ab)y \ldots + (af)t &= (an), \\ (na)x + (nb)y \ldots + (nf)t &= (nn), \\ \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \cdot \\ (fa)x + (fb)y \ldots + (ff)t &= (fn), \end{aligned}\right\},$$

for ζ, &c.

Each of these systems of equations only differs from the system of normal equation by the substitution of

$$(na)x + (nb)y \ldots + (nf)t = (nn), \quad \cdot \cdot \cdot \cdot \cdot \cdot$$

for one of the equations, viz. in the ξ-system (1), replaces the first equation

$$(aa)x+(ab)y \ \ldots \ +(af)t=(an);$$

in the η-system, it replaces the second equation

$$(ba)x+(bb)y \ \ldots \ +(bf)t=(bn),$$

and so on.

These forms of the values of ϵ_x^2, ϵ_y^2, &c., are, so far as I know, new.

§ 29. Applying the formulæ of the last section to the numerical example in § 20, viz.:—

$$\left.\begin{aligned} x-y+2z&=3,\\ 3x+2y-5z&=5,\\ 4x+y+4z&=21,\\ -x+3y+3z&=14,\end{aligned}\right\},$$

the normal equations are

$$\left.\begin{aligned} 27x+6y&=88,\\ 6x+15y+z&=70,\\ y+54z&=107,\end{aligned}\right\} \quad \ldots\ldots\ldots \text{(i)},$$

ξ is the value of x given by

$$\left.\begin{aligned} 88x+70y+107z&=671,\\ 6x+15y+z&=70,\\ y+54z&=107,\end{aligned}\right\} \quad \ldots\ldots\ldots \text{(ii)},$$

η is the value of y given by

$$\left.\begin{aligned} 27x+6y&=88,\\ 88x+70y+107z&=671\\ y+54z&=107,\end{aligned}\right\} \quad \ldots\ldots\ldots \text{(iii)},$$

and ζ is the value of z given by

$$\left.\begin{aligned} 27x+6y&=88,\\ 6x+15y+z&=70,\\ 88x+70y+107z&=671,\end{aligned}\right\} \quad \ldots\ldots\ldots \text{(iv)}.$$

The values of x_0, y_0, z_0 given by (i) are

$$x_0=\frac{49154}{19899}, \quad y_0=\frac{2617}{737}, \quad z_0=\frac{12707}{6633},$$

and solving (ii), (iii), (iv) we find

$$\xi=\frac{60742}{24577}, \quad \eta=\frac{9297}{2617}, \quad \zeta=\frac{24353}{12707},$$

and therefore

$$\epsilon_x^2 = \frac{49154}{19899}\left(\frac{60742}{24577} - \frac{49154}{19899}\right),$$

$$\epsilon_y^2 = \frac{2617}{737}\left(\frac{9297}{2617} - \frac{2617}{737}\right),$$

$$\epsilon_z^2 = \frac{12707}{6633}\left(\frac{24353}{12707} - \frac{12707}{6633}\right),$$

whence

$$\epsilon_x^2 = \frac{1294400}{(19899)^2}, \quad \epsilon_y^2 = \frac{3200}{(737)^2}, \quad \epsilon_z^2 = \frac{65600}{(6633)^2},$$

which agree with the values given by the ordinary process; for

$$(vv) = \frac{1600}{19899},$$

and, if p_x, p_y, p_z denote the weights of x_o, y_o, z_o,

$$p_x = \frac{19899}{809}, \quad p_y = \frac{737}{54}, \quad p_z = \frac{6633}{122},$$

whence

$$\epsilon_x^2 = \frac{(vv)}{p_x} = \frac{1600}{19899} \times \frac{809}{19899} = \frac{1294400}{(19899)^2},$$

$$\epsilon_y^2 = \frac{(vv)}{p_y} = \frac{1600}{19899} \times \frac{54}{737} = \frac{3200}{(737)^2},$$

$$\epsilon_z^2 = \frac{(vv)}{p_z} = \frac{1600}{19899} \times \frac{123}{6633} = \frac{65600}{(6633)^2}.$$

§ 30. At first sight it would appear that $\epsilon_x=0$, $\epsilon_y=0$, &c., if $x_o=0$, $y_o=0$, &c., respectively: this is not, however, the case, for if, say, $x_o=0$, ξ is infinite. This is evident, since x_o can only vanish if

$$\begin{vmatrix} (an), (ab), \ldots (af) \\ (bn), (bb), \ldots (bf) \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ (fn), (fb) \ldots (ff) \end{vmatrix} = 0;$$

this determinant forms the denominator of ξ, and the numerator of ξ, by § 16, is expressible as a sum of squares, and cannot in general vanish.

When $x_o=0$, the product $x_o\xi$ is to be replaced by its value

$$\begin{vmatrix} (nn), (nb), \ldots (nf) \\ (bn), (bb), \ldots (bf) \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ (fn), (fb), \ldots (ff) \end{vmatrix} \div \begin{vmatrix} (aa), (ab), \ldots (af) \\ (ba), (bb), \ldots (bf) \\ \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ (fa), (fb), \ldots (ff) \end{vmatrix}$$

and if $y_o=0$, &c., the products $y_o\eta$, &c., are to be similarly replaced.

§ 31. If $\xi=x_0$, or $\eta=y_0$, &c., then in general ϵ_x, ϵ_y, &c., vanish. For since

$$(vv) = -(na)x_0-(nb)y_0- \ldots +(nn),$$

we may regard x_0 as the value of x given by the equations

$$\left.\begin{aligned} (na)x+(nb)y \ldots +(nf)t &= (nn)-(vv),\\ (ba)x+(bb)y \ldots +(bf)t &= (bn),\\ \ldots\ldots\ldots\

As mentioned at the end of § 24, if

$$\begin{vmatrix} (bb), (bc), \ldots (bf) \\ (cb), (cc), \ldots (cf) \\ \ldots\ldots\ldots \\ (fb), (fc), \ldots (ff) \end{vmatrix} = 0,$$

then $\nabla = 0$ and therefore also $(vv) = 0$, so that the values of x_0, y_0, &c., p_x, p_y, &c., ϵ_x, ϵ_y, &c., all assume the form $0 \div 0$.

Thus, if any one of the equations

$$\xi - x_0 = 0, \quad \eta - y_0 = 0, \text{ &c.},$$

is satisfied, in general all the others are satisfied, and ϵ_x, ϵ_y, &c., all vanish. The case of exception is when the equations of condition are not of a form which suffices to determine all the unknowns, and then the whole process of solution becomes illusory.

Note on Hansen's Value of the Semi-diameter of the Moon.

By E. Neison, Esq.

In a Note in the *Monthly Notices* for November 1879 I have stated that, taking 57′ 0″ for the value adopted by Hansen for the constant of parallax, the mean semi-diameter of the Moon, employed by him in his *Tables de la Lune*, is 15′ 33″·47. This result follows from the data given by Hansen in the Introduction to his Tables; though it is not very easy from this source alone to determine the real value of the constants which he has adopted.

In the *Monthly Notices* for June 1880 (page 482), Prof. Adams points out that the mean value of the sine of the equatorial horizontal parallax employed by Hansen in his tables is really 57′ 2″·08. This it seems was pointed out in 1837 by Hansen himsef in the *Astronomische Nachrichten*, vol. xvii. page 299, in a paper which I had not seen until my attention was directed to it by Prof. Adams. The mean semi-diameter of the Moon employed by Hansen in his *Tables de la Lune*, therefore, is 15′ 34′·08, or is 0″·61 greater than stated in my previous Note. All the values given therefore in this Note must be increased by 0″·61, but this correction will not affect the accuracy of the conclusions drawn therein as to the apparent value of the lunar semi-diameter in different instruments. The empirical formula will be: Moon's semi-diameter=

$$15' \; 33'{\cdot}98 + 4''{\cdot}10 \div (1 + 0{\cdot}70 \times \text{aperture in inches}).$$

It may be added that this gives a value for the absolute semi-diameter of Moon equal to

$$15'\ 33''.36,$$

which is in close accord with the value

$$15'\ 33''.35,$$

deduced by myself from the 1500 observations of the Moon made at Greenwich between 1862 and 1877, and with the value

$$15'\ 33''.32$$

deduced by Prof. Winnecke of Strasbourg.

I would add that this correction removes a difficulty which has long perplexed me—namely, a sudden alteration in the apparent value of the mean semi-diameter of the Moon at the epoch 1862, the observed values prior and subsequent to that date seeming to differ by rather less than a second of arc. This discordance is referred to in several of my earlier papers, written six or seven years ago, when I was unable to refer to other of Hansen's publications than his Tables.

On the Determination of the Coefficient of the Parallactic Inequality in the expression for the Moon's Longitude. By E. J. Stone, M.A., F.R.S.

In the *Monthly Notices* for 1880, May and June, there appears a paper by Messrs. Campbell and Neison "on the Determination of the Solar Parallax by means of the Parallactic Inequality in the Motion of the Moon."

This paper contains some criticism, to which I do not object, of a paper of mine on the same subject printed in 1867; it contains also some erroneous corrections to the result of that paper to which I must object, and raises some points of interest which require examination.

The direct results of Messrs. Campbell and Neison's paper are as follows:—

If we select from the observations of the Moon made at Greenwich, with the Transit-Circle, during the years 1862 to 1876, both inclusive, those which were taken when the Moon passed within two days of the first and third Quarter, and throw the discordances between the mean results for errors of Hansen's Tables upon the Parallactic Inequality, the coefficient, which best satisfies the observations with a *semi-diameter adopted from the time of passage of the diameter over the meridian when near the Full Moon*, is $125''.06$.

The results are very fairly accordant, and the method is the one which has been previously generally used. This value of the coefficient of the parallactic inequality, 125″·06, would correspond to a value of the solar parallax of about 8″·81.

The coefficient of the parallactic inequality, thus determined, is, however, systematically too small by the amount of the mean excess of the apparent semi-diameters near the Full over those near the two Quarters. The value of the solar parallax 8″·81 is for the same reason too small by about one-fourteenth part of the mean excess of the semi-diameter near the Full, and it can therefore only be regarded as an inferior limiting value of the solar parallax. But although this is clear enough, there are great practical difficulties in investigating the *exact* amount by which the coefficient of the parallactic inequality thus determined should be increased. We know that the required increase cannot exceed 2″, and it most probably does not amount to quite half that quantity; this fixes, with the value of the coefficient 125″·06, which is itself of course liable to error, a superior limit to the value of the solar parallax of about 8″·96, and an inferior one of about 8″·81.

Messrs. Campbell and Neison have attempted to correct for the effects of irradiation as follows:—

They assume semi-diameter near the Quarters

= semidiameter near Full Moon − 0·25I for the winter observations,

= semidiameter near Full Moon − 0·75I for the summer observations,

and determine the quantity I by equating the values of the coefficient of the parallactic inequality which is derived from the discussion of the summer and winter observations. The result thus obtained for the coefficient of the parallactic inequality, 125″·66, is so far satisfactory that it gives an increase of about 0″·6 for the mean excess of semi-diameter near the Full over that of the Quarters, a quantity which from general considerations might be assumed as an approximation to the truth.

The value 125″·66 of the coefficient of the parallactic inequality corresponds to a value of about 8″·85 of the solar parallax. But the weak point in this argument is the assumption of the coefficients 0·25 and 0·75 of the unknown quantity I in the winter and summer equations of condition. It is not stated *how it is found* that these coefficients are approximately correct. Unless it can be shown that there are no admissible variations in the ratio of these assumptions sufficiently important to change the deduced value of the coefficient of the parallactic inequality, the assumptions themselves are not legitimate; and, although the step may be disguised, the investigation is as little satisfactory as the direct assumption, from general considerations, of the irradiational enlargement.

The following table of the values of I for the different years is given by Messrs. Campbell and Neison:—

Year.	Value I.
1876–1875	I = + 11″·92
1875–1874	= − 2·76
1874–1873	= − 7·96
1873–1872	= − 3·61
1872–1871	= − 5·22
1871–1870	= − 4·75
1870–1869	= − 0·56
1869–1868	= + 4·35
1868–1867	= + 5·06
1867–1866	= − 4·03
1866–1865	= − 1·88
1865–1864	= − 1·68
1864–1863	= − 0·74
1863–1862	= − 2·22

Upon these discordant results the authors remark as follows:—"It is obvious that any results based on such wild values must be fallacious. It shows the misleading character of values obtained from the means of large numbers of observations without examining the separate results to see if they are really accordant. The result of the preceding investigation might be regarded as discouraging, and as showing that it would not be practicable to determine in this manner the effect of the variation in the amount of irradiation at the limb of the Moon. If this were really the case, it would be most unsatisfactory, and throw grave doubt on the possibility of determining the true value of the parallactic inequality from observations of the transit of the lunar limb. For the only permissible method of ascertaining the amount of this variation in the irradiation is by this process of comparing the summer with the winter observations. If this prove to be impracticable, it involves as a necessary consequence the failure of the whole method of determining the solar parallax from these observations.

"Further consideration shows that these results are too discordant for this view to be adopted. These extreme discordances can only arise from systematic errors due to imperfections in the tables, or method of reducing the observations. These discordances must be due to the failure of the assumption which we have adopted, in common with Mr. Stone and Prof. Newcomb, and taken as the basis of our work—the assumption that in the mean of a number of observations all errors except those of the parallactic inequality can be neglected and be trusted to destroy one another."

I may mention that these remarks are not applicable to my work. I, at least, did not assume that the errors of any existing lunar tables would mutually destroy each other's effects in obser-

vations spread over half a year. But, waiving this point, which is not important, I pass to the consideration of what would appear to be the chief result of Messrs. Campbell and Neison's paper.

To avoid the unsatisfactory results found by the method already explained, the authors introduce into the equations of condition "twelve unknown quantities, or rather variable corrections," but the *same fundamental assumptions are made with respect to the irradiation.*

The value of the coefficient of the parallactic inequality thus found is 125″·64, a result almost identical with that obtained in the second case without the introduction of the additional corrections. But the importance of the additional corrections appears to me much over-estimated, and to test this point I have calculated, from the data of the paper, the values of I for the different years, and have obtained the following residual errors :—

	Residuals from Incomplete Solution.	Residuals from Complete Solution.
1876-1875	+ 12″·60	+ 9″·43
1875-1874	− 2·08	− 2·34
1874-1873	− 7·28	− 5·94
1873-1872	− 2·93	− 1·16
1872-1871	− 4·54	− 0·88
1871-1870	− 4·07	− 1·11
1870-1869	+ 0·12	+ 5·28
1869-1868	+ 5·03	+ 8·68
1868-1867	+ 5·74	+ 6·85
1867-1866	− 3·35	− 2·29
1866-1865	− 1·20	− 1·66
1865-1864	− 1·00	− 2·50
1864-1863	− 0·06	− 3·33
1863-1862	− 0·54	− 0·14

It appears to me that the residuals from the general investigation are hardly less unsatisfactory than those previously obtained, and that the introduction of these "twelve unknown quantities, or variable coefficients," and the use of methods with some pretensions to refinement and precision, have not led to a much more satisfactory result than the simpler investigation which has been so severely condemned.

The probable error attached by the authors to the result 125″·64 is only +0″·09, and the value of the solar parallax is 8″·848 ± 0·007.

It is inconceivable to me how such probable errors have been obtained.

To show that I have not objected to the method adopted by Messrs. Campbell and Neison for the determination of the irra-

diation without some grounds, I give the following numerical illustration of my objection.

Messrs. Campbell and Neison find I from the equations

$$(1)\quad m\mathrm{I} + d\mathrm{P} = -2''.00$$
$$(2)\quad n\mathrm{I} + d\mathrm{P} = -1''.40,$$

which give

$$\mathrm{I} = -\frac{0'.60}{m-n}$$

and

$$d\mathrm{P} = -1''.70 + \frac{m+n}{m-n}0''.30,$$

or

$$\mathrm{P} = 125''.06 + \frac{\frac{m}{n}+1}{\frac{m}{n}-1}0''.30.$$

The quantity $125''.06$ is derived from the general investigation and not strictly from (1) and (2) or from the adopted value minus $1''.70$.

Now, with $m = 0.75$, and $n = 0.25$, this gives

$$\mathrm{P} = 125''.66.$$

But supposing we take $m = 0.8$, and give to n the values

$$0.2,\quad 0.3,\quad 0.4,\quad 0.5,\quad \text{and}\quad 0.6$$

respectively, we should then obtain for P the corresponding values

$$125''.56,\quad 125''.72,\quad 125''.96,\quad 126''.36,\quad \text{and}\quad 127''.16.$$

In fact, we can select a value of the solar parallax and make this result apparently come from a discussion of the observations by determining the ratio $m : n$ from the equation

$$\frac{\frac{m}{n}+1}{\frac{m}{n}-1}0''.3 = \delta\mathrm{P},$$

where $d\mathrm{P}$ is the correction required by P to give the selected value of the solar parallax.

I want, therefore, an independent proof that $m = 0.75$ and $n = 0.25$ are close approximations to the true values of m and n before I can attach any importance to the correction thus obtained for irradiation.

I now pass to what, if true, would be an important result in Messrs. Campbell and Neison's paper. From the values of the coefficient of the parallactic inequality obtained by the Astronomer Royal in a discussion of the Greenwich Observations 1754 to 1843, Messrs. Campbell and Neison have inferred the existence of an inequality in the Moon's longitude $= 1''\cdot20 \sin \{D - 8(y - 1825\cdot5)\}$, where D is = mean long. of Moon – mean long. of Sun, and they have shown that such an inequality, if it existed, would change their value of the coefficient of the parallactic inequality from $125''\cdot64$ to $124''\cdot64$, and value of the solar parallax from $8''\cdot85$ to $8''\cdot78$.

No attempt is made to *prove* the *necessary existence* of such an inequality; and although, of course, its existence can be proved by its satisfying a sufficient number of the results of observation, yet if it rests simply upon this basis it is absolutely necessary that the results, derived from the assumption of its truth, should agree, not only with the old imperfect observations from which it was derived, but also with the modern observations which have been made with greatly improved instrumental means.

That it does not satisfy the results of observation has not altogether escaped the notice of the authors, for on page 405 we find:—"The computed value of the correction for the group 1843–1851 is $122''\cdot75$, whilst that actually found from the observations is $124''\cdot53$, there being a difference of $1''\cdot78$. Almost the entire portion of this difference arises from the high values found for the parallactic inequality from the observations made during the years 1846–1851, as those found for the earlier years were much lower."

But although it is thus perceived that their inequality gives nearly a minimum value where it should, according to the observations, have given a maximum value, the authors, apparently, were not prepared to face the fact; and they have attempted to escape the difficulty by reasoning which is certainly curious. They remark:—"It would, in fact, seem as if the apparent semi-diameter of the Moon had increased by $2''$ during these years, either from a change of observers or some other cause. This would have increased the apparent value of the parallactic inequality by $2''\cdot6$, and as this increase affects two-thirds of the observations, it would correspond to a fictitious increase of $1''\cdot73$, whilst that actually observed was $1''\cdot78$." I need hardly point out that this step is equivalent to a tacit assumption of the existence of the forty-five year period inequality, and that discordances between its results and those given by observations arise from errors of observations. Such assumptions are always unsafe, and are particularly unsafe in this case, when the only evidence in favour of the existence of the inequality consists of certain discordances between the results obtained by means of the imperfect instruments in use from 1750 to 1816; and when the discussion of these results is complicated by changes of instruments during the period, and the acknowledged

impossibility of any satisfactory determination of the instrumental semi-diameter upon which so much depends.

In the year 1867, when the question whether the true value of the solar parallax was nearer 8″·58 or 8″·90 was an open one, I selected some 2,000 observations of the Moon made near the Quarters at Greenwich with the Altazimuth and Transit-Circle, to test, for my own satisfaction, the legitimacy of the proposed increase of the solar parallax. My method was the same as that followed by Messrs. Campbell and Neison, in section 1, and the result for the coefficient of the parallactic inequality was 125″·36. I had not the slightest expectation of fixing the coefficient within 0″·1, but I stated then and I believe now that the error cannot amount to more than 0″·4, and is probably much less. The semi-diameter used was that obtained from observations near the Full, and the value of the solar parallax thus deduced, about 8″·84, was therefore a minimum value of the result. This investigation appeared to entirely confirm the necessity of the proposed increase of the solar parallax. The result was briefly indicated in the *Monthly Notices* for Nov. 1867.

Messrs. Campbell and Neison profess their ignorance of the exact observations made use of by me, of the Tables through which I have compared the observations with theory, and of any systematic corrections which I may have applied to the results. Their position would therefore have been logically unassailable had they expressed themselves dissatisfied with the result on account of the impossibility of an examination of its freedom from systematic errors; but, instead of taking this course, they have proceeded to investigate the corrections which my result requires; and after thus reducing it from 125″·36 to 123″84, they appeal to the difference between this, supposed corrected result, and their own, as tending to strengthen the hypothesis of the real existence of the forty-five year period inequality.

Unfortunately for this argument, the corrections which they have applied to my result are certainly erroneous. The corrections which that result requires, if any, are small, and tend rather to increase than to decrease the resulting value of coefficient.

The observations made use by me in 1867 were:—

(1) The Altazimuth Observations, 1848–1861.

(2) The Altazimuth Observations, 1862–1866.

(3) The Transit-Circle Observations, 1853–1861.

(4) The Transit-Circle Observations, 1862–1865.

The observation in sections (1) and (3) were compared directly with Burckhardt's longitudes. Those in (2) and (4) were compared with Hansen's Tables.

After the discovery, by Professor Adams, of the errors in Burckhardt's expression for the parallax, the whole of the reduced

observations were systematically corrected by the Astronomer Royal for errors of parallax and semi-diameter. It is these corrected results which were used by me. The semi-diameters were carefully discussed and separate determinations made for the two instruments, and the corrections required to the coefficient of the parallactic inequality on account of the errors in the coefficient of Burckhardt's variation, annual equation and *term* sin 3D were determined in mean results and applied.

As the results for the Altazimuth instrument extend now over more than thirty years, and are valuable, I give the separate results, extracted from my old papers, for the years 1848 to 1866, and have extended them to 1878 on the same principles. I profess here no attempt to secure greater accuracy than $0''{\cdot}2$.

The results 1848–1861 are derived from the errors of Burckhardt's longitudes after the observations have been reduced with Adams's parallax and a mean semi-diameter $= 15'\ 34''{\cdot}52$.

From a direct comparison between the values of the semi-diameters adopted by Adams and Hansen we have

$$\text{Adams' = Hansen's } +0''{\cdot}52.$$

The corrections to Hansen's semi-diameter now used at Greenwich are

$+0''{\cdot}49$ for Azimuth Observations,

$+1''{\cdot}01$ for Altitude Observations.

My value agrees very closely indeed with that derived from the Azimuth Observations and, although it is slightly smaller than the mean result from the Azimuth and Altitude Observations, I appear to have investigated the necessary correction; and it is in my opinion doubtful whether it should be changed.

[1] The correction $+1''{\cdot}56$ has been applied to the results obtained directly from the observations for the errors of the coefficients in Burckhardt's Tables. Almost the whole of this correction for the Altazimuth observations arises from error in coefficient of the term sin 3D.

	Value of P.		Value of P.
1848	$124''{\cdot}13$	1855	$125''{\cdot}62$
1849	123·52	1856	125·17
1850	125·70	1857	124·40
1851	126·18	1858	124·08
1852	126·45	1859	125·03
1853	126·98	1860	125·38
1854	127·50	1861	126·17

Mean value from 1848–1856 = $125''{\cdot}69$; 1833–1861, $125''{\cdot}59$.

These are derived through Burckhardt's Tables.

From Hansen's Tables with semi-diameter corrected:—

	P.		P.
1862	125″·92	1871	124″·90
1863	124·32	1872	124·80
1864	125·22	1873	125·25
1865	125·12	1874	125·68
1866	125·05	1875	123·36
1867	125·40	1876	125·35
1868	125·04	1877	125·44
1869	124·72	1878	125·81
1870	124·72		

It will be seen that the existence of the inequality proposed by Messrs. Neison and Campbell is not at all confirmed by these results. Instead of requiring a large positive correction about 1850–1855, the value of P is very large; and if it be considered that the results derived through Burckhardt's Tables are not to be trusted for the results of separate years, similar evidence against this assumed inequality is shown by the later results.

The observations about 1870 should give a maximum result, if the inequality really exists; but this is not shown to be the case in the Transit-Circle results collected by Messrs. Campbell and Neison, whilst for the Altazimuth observations we have:—

	Uncorrected.	With Neison's proposed Correction.	
P =	125″·17	124″·33	1862–1867
	124·84	113·66	1868–1872
	125·15	124·31	1873–1878

The greatest discordance between the uncorrected results is 0″·33, whilst this is increased to 0″·67 by the introduction of the correction proposed by Messrs. Campbell and Neison.

It would almost appear that, so far from this forty-five year period inequality satisfying the observations, its effects are nearly reversed, and give a maximum instead of a minimum about 1870, and a minimum instead of a maximum about 1848.

It is clear however to me, that the attempt to introduce this term is a retrograde step, and I have freely criticised the paper because I know how difficult it is to get rid of such results, when once they find their way into our *Notices*.

It appears to me clear that the value of the parallactic inequality does not differ greatly from $125''\cdot23+x$, where x is some positive quantity which probably does not differ greatly from 0″·5, but is certainly less than 2″.

In this case the true value of the solar parallax is not very

different from 8″·86, and is almost certainly confined within the limits 8″·82 and 8″·97.

The value of these investigations on the Sun's mean distance is chiefly indirect.

There is certainly no error in an assumed value about 8″·88 which is of any direct importance in our present astronomy. That such is the case, is clearly shown by the fact that we are unable by any one method to prove clearly the error in the assumed value, or, in other words, the assumption of a value about 8″·88 leads to no practical errors which can be laid hold of with certainty. If this were not the case, the correction of the assumed value would present no difficulty.

But although this statement is, I believe, correct, yet the indirect effects of these investigations must, if fairly conducted, be of very great importance. I know of no method free from suspicion of liability to systematic errors, and all discordances between the values of the solar parallax deduced from observations must be valuable as affording indications of the existence of systematic errors in the different methods adopted, which indications should ultimately lead to improve methods of observation or reduction.

In my own investigations I have found all sorts of values from 8″·84 to 8″·94, and I am, at present, quite indisposed to accept any one of these values to the exclusion of a general mean.

The Discovery of κ Pegasi as a close Double Star.

By S. W. Burnham, Esq.

I have recently found that *κ Pegasi* is a very close double star. There is not more than half a magnitude difference in the components. Unfortunately, during the last three months, nights when stars of this class could be properly measured have been rare, and I have only been able to secure four observations, as

A and B.

141°·0	0′·32	1880·613
133·7	0·30	·627
139·8	0·23	·725
135·2	0·22	·766
137·9	0·27	1880·68

These distances are too large; I am confident the true distance will not exceed 0″·2. It is a fine test for the real working

power of a telescope. Only those of the best definition will show it well.

As a wide pair, this star has been known since the time of Sir William Herschel (H N. 43), and is Σ 2804 of the Dorpat Catalogue. My measures of the distant star were generally made when the conditions were too unfavourable to observe the close pair.

A, B and C.

304°·0	11″·55	1880·553
302·3	·90	·613
301·7	·85	·627
304·6	·75	·695

There is some change in angle and distance, due to the proper motion of the large star, as will appear from the following mean results:—

Struve	308°·5	11″·01	1831·56
Dembowski	303·9	11·60	1864·84
Burnham	303·1	11·76	1880·60

The physical relation of the close pair is manifest from the common proper motion of the components, as otherwise it would have been a very easy pair at the time of Struve's measures of the distant star, and certainly would have been detected by him.

Chicago,
1880, Oct. 13.

Observations of Ceraski's Variable Star in Cepheus.

By George Knott, Esq.

Having obtained observations of two recent minima of Ceraski's interesting short-period variable star in *Cepheus*, B.D.+81° 25, I beg to present them to the Society.

Warned by Lord Lindsay's Dun Echt Circular No. 10, which reached me on the morning of October 23, I was prepared to watch for the minimum predicted for the same night, which was fortunately fairly clear, with the exception of a cloudy interval which prevented all observation between $9^h\ 5^m$ and $10^h\ 25^m$. The night of October 28, the date of the next observable minimum, was hopelessly cloudy, and no observations of any kind were possible; but November 2 was fine, and the minimum was observed under favourable circumstances.

The magnitude of the variable at the several times was determined partly by gauging (by the method of limiting apertures),

and partly by comparing it with neighbouring stars, the magnitudes of which are gauged. The magnitude scale is practically that of the *Durchmusterung*, the assumed light-ratio being 2·512. The dates of observation are in Greenwich Mean Time :—

Minimum of October 23.

Time of Observation.	Star's observed Magnitude.	Time of Observation.	Star's observed Magnitude.
h m	m	h m	m
9 5	8·1	12 44	8·8
10 25	9·0	13 7	8·6
10 47	9·05	13 16	8·5
11 7	9·1	13 50	8·1
11 39	9·0	14 0	8·0
12 30	8·95		

Minimum of November 2.

Time of Observation.	Star's observed Magnitude.	Time of Observation.	Star's observed Magnitude.
h m	m	h m	m
6 19	7·3	11 0	9·05
6 55	7·3	11 40	9·1
7 10	7·3	12 10	9·05
7 52	7·4	12 20	8·8
8 0	7·4	12 30	8·6
8 18	8·1	12 47	8·4
8 43	8·4	13 0	8·1
9 35	8·9	13 10	8·0
9 45	9·0	13 55	7·4
10 30	9·1	14 5	7·3

Projecting the observations on cross-ruled paper, and reading off from the light curve, I inferred October 23 $11^h\ 10^m$ as the date of the first minimum. It is quite possible, however, that the slight changes about minimum may be more apparent than real, and that the epoch of mean phase should be taken about 17^m later. The minimum of November 2 appears to have occurred at about $11^h\ 0^m$.

When at its full brightness, the colour of the Variable is white, or bluish white, very similar to that of its neighbour B.D.+81° 30. At the minimum it is ruddy or ruddy-orange. When observing the star on October 23 I noticed a small bluish companion, of about $11\frac{1}{2}$ mag. P=60° D=10″, and suspected a second, at a slightly greater distance, with angle of position 330°. When the Variable was at minimum on November 2, both these small companion stars were well seen, and judged to be of about the $11\frac{1}{2}$ and 13 magnitudes respectively.

I have gauged the magnitudes of several of the neighbouring

stars in the *Durchmusterung* with the following results, giving for comparison the magnitudes assigned to them in the *Durchmusterung* and in Carrington's Red Hill Catalogue :—

No. in B. D.	Mag. B. D.	Mag. Carrington.	Mag. Knott.
+81° 13	6·5	6·2	6·5
22	9·2	9·5	9·4
26	9·5		10·4
27	8·6	8·7	8·4
30	8·3	8·0	8·1
34	8·7	9·1	8·6

The star No. 26 does not appear to have been observed at Red Hill, and the magnitude estimate in the *Durchmusterung* seems to me to be rather too high.

I may note, in concluding, that the Variable was observed on three occasions at Red Hill in the year 1855, the dates of observation and corresponding magnitudes being December 19, 8·0 ; 21, 8·0 ; 30, 9·0. The star was probably near minimum at the last epoch.

Knowles Loge, Cuckfield,
1880, *November* 11.

On the Annual Parallax of the Star P III 242. By Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland.

In the *Monthly Notices* vol. xx. p. 8 is a paper by O. Struve "On a Star which would be suitable for a Parallax Series." The star in question is P III 242, and its position for 1879·0 is $\alpha = 3^h\ 59^m\ 30^s$ and $\delta = +37°\ 45''.3$. Argelander in his Catalogue of 560 stars had pointed out that P III 242 probably formed a wide binary system with the next following star of his Catalogue 50 *Persei*, on account of the equality in direction and quantity of their proper motions.

Struve remarks also that P III 242 is a double star of Herschel's first class (No. 531 of O. Struve's Catalogue), the components being of 6–7th and 8–9th magnitudes respectively, and 3″ or 4″ distant. The physical connection of the two components of P III 242 appears to be established by their equal proper motions. A fourth star, Arg. zone +37°, No. 877 (Mag. 7–8) is south preceding P III 242 at a distance of nearly 4′. This star does not belong to the system formed by P III 242 and 50 *Persei*, for the changes in its position with respect to P III 242 correspond exactly to the proper motion of the latter. "This star, therefore," says Struve in conclusion, "would be a very qualified object of comparison for determining the relative parallax of P III 242, for which a considerable amount is indicated

by the proper motion and by the probable physical connection with 50 *Persei* at 15′ distance."

So far as I know, no measures have hitherto been published with the view of testing whether Struve's surmise as to the existence of a parallax for P III 242 could be substantiated. I therefore commenced a series of observations in January 1879 of the distance and position of the comparison star which Struve suggested from the larger star of the pair P III 242. The instrument employed was the South Equatoreal at Dunsink Observatory, with the Pistor and Martin filar micrometer. The methods of observation and of reduction are the same as those employed by Dr. Brunnow and myself in previous investigations. See Parts I., II., III. of the "Dunsink Observations."

In an important feature, however, the observations now to be discussed are very different from those which had previously been made with our micrometer. The distance in this case was no less than $237''\pm$, which is greatly in excess of the distances measured in the regular series of parallax observations contained in our previous publications. Had there been any suitable comparison star nearer to P III 242 I should certainly have preferred it, for the distance $237''$ is too great to be measured by our micrometer with the accuracy which can be attained when the distance is only about one or two minutes. From this cause the results of the observations are not so satisfactory as I would wish, though they are quite sufficient to show that P III 242 has no large parallax.

The following are the observations which I have made of the distance and position, corrected for refraction and reduced to the mean places of the stars at the epoch 1879·0 :—

Dist. and Pos. of A.Z.+37°, No. 877 from P III 242.

Date 1879.	Distance.	Position.	
	″	°	″
Jan. 11	237·558	207	17·35
Feb. 7	237·529	207	23·47
19	237·074	207	13·16
22	237·174	207	16·04
23	237·695	207	10·25
25	237·348	207	16·96
Mar. 1	237·220	207	9·08
19	237·605	207	15·99
Apr. 4	237·422	207	9·27
6		207	14·00
10	237·495	207	15·66
Aug. 14	237·268	207	19·18
22	236·973	207	8·47
23	237·177	207	12·83

Date.	Distance.	Position.	
1879.			
Sept. 17	237″·242	207°	16′·28
Oct. 4	237·151	207	20·24
5	237·203	207	17·28
17	237·497	207	16·14
25	237·315	207	17·12
25	237 049	207	22·83
Nov. 1	236·965	207	8·40
2	237·305	207	17·66
8	237·041	207	19·72
8	237·423	207	21·57
11	237·588	207	12·86
Dec. 3	237·647	206	59·53
5	237·186	207	5·91
17	237·587	207	25·42
18	237·215	207	29·27
24	237·130	207	22·88
1880.			
Jan. 9	236·715	207	20·66

According to O. Struve (loc. cit.), the annual proper motion in right ascension is $+0^{s}\cdot0167$, and in declination $-0''\cdot152$. It hence appears that the arc moved over in one year by P III 242 is $0''\cdot2497$, while the position angle of the star in the position it will occupy next year measured from the present position is $127°\cdot5$. The correction to be applied to the observed distance in order to reduce the observed distance to that between the places at the epoch is $+0''\cdot04407$ per annum, while the corresponding correction to the observed position angle is $-3'\cdot565$, or in arc $-0''\cdot2457$.

The adopted mean distance at the epoch is $237''\cdot320$, and the adopted mean position is $207° 13'\cdot86$.

From the usual formulæ it is found that when $\odot$ is the Sun's longitude, R the Sun's radius vector, and π the annual parallax of P III 242, the correction to be applied to the observed distance to clear it from the effects of parallax is (the figures in brackets denoting logarithms)

$$-[9\cdot82787]\pi R \cos(\odot - 174^{\circ}\ 56'\ 0'').$$

while the corresponding correction of the observed position angle is

$$-[9\cdot90007]\pi R \cos(\odot - 142^{\circ}\ 8'\ 29'').$$

Assuming that $-x$ is the correction to be applied to the

assumed mean distance, while x' is the correction to the assumed value of the proper motion in distance, and κ is a possible difference in the coefficients of aberration of the two stars, then we have from the observations of the distance the following equations of condition :—

P III 242.

Equations of Condition, from Distance.

					Residuals.	Weight.
x	$+ \cdot0274\,x'$	$+ \cdot2877\,\pi$	$- \cdot6038\,\kappa$	$+ \cdot239 = 0$	$+ \cdot021$	
	$+ \cdot1013$	$+ \cdot5308$	$- \cdot4011$	$+ \cdot214 = 0$	$+ \cdot052$	
	$+ \cdot1342$	$+ \cdot6034$	$- \cdot2791$	$- \cdot240 = 0$	$- \cdot374$	$\frac{1}{2}$
	$+ \cdot1424$	$+ \cdot6175$	$- \cdot2466$	$- \cdot140 = 0$	$- \cdot268$	
	$+ \cdot1451$	$+ \cdot6218$	$- \cdot2357$	$+ \cdot382 = 0$	$+ \cdot257$	
	$+ \cdot1506$	$+ \cdot6299$	$- \cdot2134$	$+ \cdot035 = 0$	$- \cdot086$	
	$+ \cdot1615$	$+ \cdot6438$	$- \cdot1684$	$- \cdot093 = 0$	$- \cdot209$	
	$+ \cdot2108$	$+ \cdot6672$	$+ \cdot0402$	$+ \cdot294 = 0$	$+ \cdot229$	
	$+ \cdot2546$	$+ \cdot6338$	$+ \cdot2212$	$+ \cdot113 = 0$	$+ \cdot081$	
	$+ \cdot2711$	$+ \cdot6088$	$+ \cdot2851$	$+ \cdot187 = 0$	$+ \cdot172$	
	$+ \cdot6160$	$- \cdot5645$	$+ \cdot3734$	$- \cdot025 = 0$	$+ \cdot057$	$\frac{1}{2}$
	$+ \cdot6379$	$- \cdot6091$	$+ \cdot2953$	$- \cdot319 = 0$	$- \cdot241$	$\frac{1}{2}$
	$+ \cdot6407$	$- \cdot6139$	$+ \cdot2851$	$- \cdot115 = 0$	$- \cdot038$	
	$+ \cdot7091$	$- \cdot6739$	$+ \cdot0113$	$- \cdot047 = 0$	$+ \cdot011$	
	$+ \cdot7557$	$- \cdot6455$	$- \cdot1825$	$- \cdot136 = 0$	$- \cdot089$	
	$+ \cdot7584$	$- \cdot6421$	$- \cdot1935$	$- \cdot083 = 0$	$- \cdot038$	
	$+ \cdot7913$	$- \cdot5865$	$- \cdot3217$	$+ \cdot212 = 0$	$+ \cdot249$	$\frac{1}{2}$
	$+ \cdot8132$	$- \cdot5352$	$- \cdot4002$	$+ \cdot031 = 0$	$+ \cdot069$	
	$+ \cdot8132$	$- \cdot5352$	$- \cdot4002$	$- \cdot235 = 0$	$- \cdot201$	
	$+ \cdot8323$	$- \cdot4818$	$- \cdot4628$	$- \cdot318 = 0$	$- \cdot286$	
	$+ \cdot8351$	$- \cdot4736$	$- \cdot4712$	$+ \cdot022 = 0$	$+ \cdot053$	
	$+ \cdot8515$	$- \cdot4214$	$- \cdot5187$	$- \cdot241 = 0$	$- \cdot211$	
	$+ \cdot8515$	$- \cdot4214$	$- \cdot5187$	$+ \cdot141 = 0$	$+ \cdot171$	
	$+ \cdot8597$	$- \cdot3935$	$- \cdot5404$	$+ \cdot306 = 0$	$+ \cdot337$	
	$+ \cdot9199$	$- \cdot1611$	$- \cdot6507$	$+ \cdot368 = 0$	$+ \cdot405$	
	$+ \cdot9254$	$- \cdot1384$	$- \cdot6561$	$- \cdot093 = 0$	$- \cdot051$	
	$+ \cdot9583$	$+ \cdot0015$	$- \cdot6709$	$+ \cdot309 = 0$	$+ \cdot357$	
	$+ \cdot9610$	$+ \cdot0133$	$- \cdot6708$	$- \cdot062 = 0$	$- \cdot013$	
	$+ \cdot9774$	$+ \cdot0835$	$- \cdot6655$	$- \cdot147 = 0$	$- \cdot091$	
	$+ 1 \cdot0219$	$+ \cdot2699$	$- \cdot6150$	$- \cdot560 = 0$	$- \cdot480$	

The normal equations deduced by the method of least squares, and making allowance for the weights, are :—

$$
\begin{aligned}
+28{\cdot}000\ x + 17{\cdot}039\ x' - 1{\cdot}1059\ \pi - 8{\cdot}6094\ \kappa + {\cdot}18500 &= 0,\\
+17{\cdot}039\ x + 13{\cdot}505\ x' - 4{\cdot}1275\ \pi - 6{\cdot}6243\ \kappa - {\cdot}58021 &= 0,\\
-\ 1{\cdot}1059\ x - \ 4{\cdot}1275\ x' + 7{\cdot}1845\ \pi + \ {\cdot}77499\ \kappa + {\cdot}85472 &= 0,\\
-\ 8{\cdot}6094\ x - \ 6{\cdot}6243\ x' + 7{\cdot}7499\ \pi + 5{\cdot}3655\ \kappa - {\cdot}029128 &= 0.
\end{aligned}
$$

Solving these, we deduce

$$
\begin{aligned}
x &= -0''{\cdot}1459 \pm 0''{\cdot}08,\\
x' &= +0{\cdot}3009 \pm 0{\cdot}15,\\
\pi &= +0{\cdot}0163 \pm 0{\cdot}09,\\
\kappa &= +0{\cdot}1405 \pm 0{\cdot}12.
\end{aligned}
$$

The sum of the squares of the residuals is 1·2732, from which the probable error of one observation is $\pm 0''{\cdot}15$. The sum of the squares of the absolute terms is 1·4638.

We next proceed to form the equations of condition from the observations of the position angle. In a complete series of measures four observations of the parallel and four of the position angle have been made. Owing to the great distance of the stars, the measurements of the position angle (estimated in arc) are not very satisfactory, and on two occasions (Dec. 3 and Dec. 5, 1879) the discrepancies have attained to very undesirable dimensions. The residual on Dec. 3 is no less than $-1''{\cdot}332$, but only a weight of $\frac{1}{2}$ attaches to this result, because it was based on but two observations of the parallel and two of the position. The notes at the time of observation are, "Snow and severe frost; low and hazy but tolerably steady." On the next night of observation, Dec. 5, the number of observations was complete, and they were fairly accordant; the notes at the time record, "Good definition; thaw; occasional clouds." The residual on this occasion is $-0''{\cdot}895$. It will be noticed that these observations occur at dates when the parallax produces but very little effect, the coefficient being +·2536 on the first occasion, and +·2801 on the second.

The following are the equations of condition which are deduced from the position angle :—

P III 242.

Equations of Condition, from Position Angle.

					Residuals.	Weight.
x	$+ {\cdot}0287\,x'$	$+ {\cdot}6715\,\pi$	$- {\cdot}4089\,\kappa$	$+ {\cdot}234 = 0$	$+ {\cdot}103$	
	$+ {\cdot}1028$	$+ {\cdot}7839$	$- {\cdot}0470$	$+ {\cdot}638 = 0$	$+ {\cdot}544$	
	$+ {\cdot}1352$	$+ {\cdot}7783$	$+ {\cdot}1186$	$- {\cdot}082 = 0$	$- {\cdot}152$	$\frac{1}{2}$
	$+ {\cdot}1437$	$+ {\cdot}7714$	$+ {\cdot}1609$	$+ {\cdot}115 = 0$	$+ {\cdot}052$	
	$+ {\cdot}1465$	$+ {\cdot}7686$	$+ {\cdot}1752$	$- {\cdot}286 = 0$	$- {\cdot}343$	

				Residuals.	Weight.
+ ·1518 x'	+ ·7627 π	+ ·2011 κ	+ ·176 = 0	+ ·120	
+ ·1624	+ ·7480	+ ·2534	− ·370 = 0	− ·417	
+ ·2119	+ ·6367	+ ·4743	+ ·095 = 0	+ ·096	
+ ·2558	+ ·4856	+ ·6308	− ·380 = 0	− ·336	¾
+ ·2613	+ ·4639	+ ·6471	− ·055 = 0	− ·006	⅜
+ ·2723	+ ·4189	+ ·6774	+ ·057 = 0	+ ·116	
+ ·6179	− ·8058	+ ·0053	+ ·215 = 0	+ ·350	
+ ·6398	− ·7980	− ·1014	− ·530 = 0	− ·411	½
+ ·6427	− ·7959	− ·1153	− ·230 = 0	− ·113	
+ ·7106	− ·6747	− ·4268	− ·008 = 0	+ ·049	
+ ·7572	− ·5207	− ·6017	+ ·254 = 0	+ ·265	
+ ·7599	− ·5101	− ·6106	+ ·049 = 0	+ ·057	
+ ·7927	− ·3731	− ·7022	+ ·038 = 0	− ·061	⅜
+ ·8141	− ·2742	− ·7465	+ ·024 = 0	− ·019	
+ ·8143	− ·2735	− ·7468	+ ·419 = 0	+ ·376	
+ ·8335	− ·1805	− ·7748	− ·582 = 0	− ·642	¾
+ ·8364	− ·1663	− ·7780	+ ·056 = 0	− ·006	
+ ·8522	− ·0872	− ·7910	+ ·195 = 0	+ ·120	¾
+ ·8523	− ·0865	− ·7911	+ ·322 = 0	+ ·247	⅗
+ ·8609	− ·0435	− ·7947	− ·281 = 0	− ·362	
+ ·9205	+ ·2536	− ·7531	− 1·216 = 0	− 1·332	½
+ ·9261	+ ·2801	− ·7434	− ·777 = 0	− ·895	
+ ·9598	+ ·4318	− ·6639	+ ·562 = 0	+ ·435	
+ ·9624	+ ·4427	− ·6564	+ ·827 = 0	+ ·699	
+ ·9789	+ ·5091	− ·6044	+ ·381 = 0	+ ·251	
+ 1·0233	+ ·6155	− ·4916	+ ·217 = 0	+ ·090	

The normal equations deduced from these by the method of least squares are, after making allowance for the weights :—

$$
\begin{aligned}
+27{\cdot}250\,x &+ 16{\cdot}223\,x' + 4{\cdot}0258\,\pi - 8{\cdot}1716\,\kappa + 1{\cdot}0844 &&= 0,\\
+16{\cdot}223\,x &+ 12{\cdot}708 - {\cdot}1377 - 8{\cdot}3986 + {\cdot}77684 &&= 0,\\
+\ 4{\cdot}0258\,x &- {\cdot}1377 + 8{\cdot}5200 + 1{\cdot}6929 + {\cdot}85405 &&= 0,\\
-\ 8{\cdot}1716\,x &- 8{\cdot}3986 + 1{\cdot}6929 + 8{\cdot}6527 - {\cdot}78159 &&= 0.
\end{aligned}
$$

From which we obtain—

$$
\begin{aligned}
x &= +0{\cdot}''0185 \pm 0{\cdot}''14,\\
x' &= +0{\cdot}0076 \pm 0{\cdot}27,\\
\pi &= -0{\cdot}1371 \pm 0{\cdot}11,\\
\kappa &= +0{\cdot}1420 \pm 0{\cdot}18.
\end{aligned}
$$

The sum of the squares of the absolute terms of the equations is +4·3105, and the sum of the squares of the residuals is +4·1077; from whence the probable error in arc of one complete observation of the position angle is

$$\pm 0''.263.$$

If we combine the two values of the parallax, making due allowance for the weights, we obtain as the final result of this series of observations

$$\pi = -0''.045 \pm 0''.070.$$

If this result were to be strictly interpreted, it would mean that the comparison star was actually the less distant of the two. Observing, however, that the probable error is greater than the parallax itself, it would seem unsafe to draw any conclusion from these observations, except that the difference between the parallaxes of P III 242 and +37° 877 is too small to be measured with accuracy.

A Determination of the Diameter of Mars at the Mean Distance of the Earth from the Sun. By A. M. W. Downing.

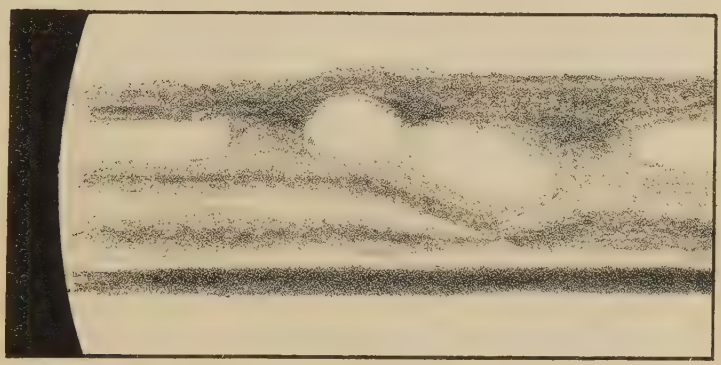
Recent investigations have shown conclusively that Le Verrier's value of the diameter of *Mars*, which has been adopted in the English *Nautical Almanac* since 1866, is considerably too large.

Thus the diameter according to

Le Verrier is	11″·10	(*Annales de l'Observatoire*, tome vi.)
Hartwig	„ 9·352	(*Publ. Ast. Ges.*, No. xv.)
Young	„ 10·068	(*Am. Journal*, March 1880)
Pritchett	„ 9·486	(*A. N.* No. 2309).

Under these circumstances it is desirable that the value of the diameter of *Mars*, found from the observations made with the Greenwich Transit-Circle, should be computed, and in the present paper I give the results obtained from the investigation. This determination cannot of course compare in accuracy with values derived from heliometer or other double-image measures, but is rather intended to supply the proper value of the diameter to be used when from accident of weather, or defect of illumination, only one limb of the planet can be observed at Greenwich. It must, however, be remembered that we have more than 500 measures of the diameter made with the same instrument, since its erection in 1851.

The Great Red Spot.



Oct, 18th. 11h 20m Portion of Gt Equatorial belt on W. limb.
showing two white spots.

Group of Dark Spots in N. Hemisphere.

Spottiswoode & Co. Lith. London

From 1851 to 1865, the value of the diameter of *Mars* assumed in the *Nautical Almanac*, and with which the Greenwich observations have been compared, was $8''{\cdot}87$. Let the true diameter$=8''{\cdot}87\ (1+y)$, and let x be the constant correction to the assumed value for irradiation, then each observation of vertical diameter of the planet gives an equation of the form

$$x+8''{\cdot}87(1+y) = \text{observed diameter.}$$

There are 272 observations of vertical diameter in the years 1851–1865, and the equations of condition being solved by the method of least squares, we have

$$\begin{aligned} 272\ \ x+\ 3881{\cdot}2\ \ y &= \ 983''{\cdot}13 \\ 3881{\cdot}2\ x+59708{\cdot}42\ y &= 14396{\cdot}94 \end{aligned}$$

whence

$$\begin{aligned} x &= +2''{\cdot}399\ \pm 0''{\cdot}261 \\ y &= +0{\cdot}0852 \pm 0{\cdot}018, \end{aligned}$$

it being assumed that each observation is a measure of the same physical quantity, *i.e.* neglecting the ellipticity of the disk.

The probable error of a single measure of diameter, found from Lüroth's extension of Peters' formula, viz.,

$$\epsilon = 0{\cdot}8453\ \frac{\Sigma e}{\sqrt{n(n-\mu)}},$$

where Σe is the sum of the residuals without regard to sign, n the number of equations, μ that of the unknown quantities, is

$$\pm 1''{\cdot}158.$$

From this series of observations therefore we have

$$\text{True diameter} = 8''{\cdot}87(1+y) = 9''{\cdot}625 \pm 0''{\cdot}156. \qquad (1)$$

Since 1866 the value of the diameter adopted is $11''{\cdot}10$, therefore we have

$$x'+11''{\cdot}10(1+y') = \text{observed diameter,}$$

and solving by the method of least squares, the 265 equations derived from the observations of vertical diameter made since 1866, there results:—

$$\begin{aligned} 265\ \ x'+\ 4488{\cdot}1\ \ y' &= \ 78''{\cdot}88, \\ 4488{\cdot}1\ x'+83671{\cdot}97\ y' &= 412{\cdot}37, \end{aligned}$$

whence

$$x' = +2''.340 \pm 0''.235,$$
$$y' = -0.1206 \pm 0.013,$$

and

$$\text{True diameter} = 11''.10(1+y') = 9''.761 \pm 0''.147. \qquad (2)$$

Combining (1) and (2), we obtain for the final value of diameter of *Mars* as measured with the Greenwich Transit-Circle—

$$9''.697 \pm 0''.107.$$

If the adopted diameter be $9''.697$, x and x' will require slight modifications; let a and b be the corrected values, then

$$a + 9''.697 = 2''.399 + 9''.625, \quad \therefore a = 2''.327$$
$$b + 9.697 = 2.340 + 9.761, \quad \therefore b = 2.404.$$

Combining a and b, we find

$$\text{Constant Correction} = 2''.369 \pm 0''.175.$$

This correction is unusually large; for instance, with the Washington Mural-Circle, the aperture of the object glass of the telescope of which is four inches, the corresponding quantity is found to be $1''.192$.

It might be expected from *a priori* considerations that the larger aperture would give a smaller irradiation-constant; there is, however, evidence to show that the value of the correction in question does not appear to follow any law depending on the aperture of the telescope employed.

1880, *November* 11.

The Motions and Varieties of the Jovian Spots.

By W. F. Denning, Esq.

Those who have telescopically observed *Jupiter* during the last few months can hardly fail to have been struck with the very remarkable changes exhibited in the positions and forms of his spots. This remark does not apply, however, to the great red spot which has maintained a constancy of appearance and regularity of motion, in singular contradiction to the white oval patches, alternating with dark spaces along the equator, and to a series of dark spots which have been visible on a belt lying N. of the equatorial zone.

As to the large spot, I always see it with a minute black speck at its interior f. end. This is distinctly visible when either on the

east or west limb; more plainly when in the latter position; so that I infer the great spot is not a cavity, or the black point alluded to, if situated on its sloping side, must disappear as it approached the west limb. The ends of the Great spot taper, as in following sketch (see lithograph). It lies perfectly parallel with the equatorial belt, which shows no perceptible depression, as some observers have intimated, in that portion immediately adjacent to the spot.

On Oct. 18, while watching the transits of Sat. I. and II., I noticed an unusually bright patch projecting out of the great S. belt towards the equator. It was followed by a white oval marking, and as it neared the W. limb I made a sketch as follows (see lithograph).

This object was the brightest and most conspicuous of its class on the planet, and from the date that it was first seen, on Sept. 18 at $11^h\ 50^m$, until Nov. 23, it was carefully reobserved on every possible occasion, and its times of transit across the central meridian cautiously estimated. Relatively to the red spot, it soon manifested a great change of position. It was seen at places considerably in advance of that predicted on the assumption of a rotation period of $9^h\ 55^m\ 34^s$. It passed the central meridian at about $10^h\ 30^m$ on Oct. 18, and on Oct. 20 at $11^h\ 38^m$. The period was approximately $5\frac{1}{2}$ minutes less than the red spot. After Oct. 20th it was closely watched, and by Nov. 21 had been reobserved on thirteen nights. On the latter date it crossed the meridian at $10^h\ 41^m$, and the resulting observed period from a mean of all the observations was $9^h\ 50^m\ 5^s$, which, though depending upon eye-estimations of the transits, cannot be far wrong. If this rapid motion of the spot, from west to east around *Jupiter*, continues, it will complete its circuits of the planet in about 45 days=108 rotations of the great spot.

Mr. H. Corder at Writtle, near Chelmsford, had, with only a $4\frac{1}{2}$-in. reflector, noticed a similarly rapid movement of the white equatorial spots from his observations in the autumn of 1879 (see *Observatory*, December 1879, pp. 238–9). He inferred an "independent rotation, relatively to the red spot, in about 40 days."

On Oct. 23, at 11^h, I saw several minute, dark objects, looking like a train of Sun-spots, upon a dusky belt to the N. of the great equatorial shading. I saw them again on Oct. 29, 30, 31, Nov. 2, 3, 4, and 8, and they showed remarkable changes. The group was evidently lengthening in the direction of the belt, and the constituent spots varied from day to day. On Oct. 29 the whole group passed the central meridian in less than an hour, whereas on Nov. 8 it occupied double that interval. The spots had further developed to such an extent by Nov. 23 as to range over 120 degrees of longitude, for they were $3^h\ 19^m$ in crossing the meridian of *Jupiter* on that date. I figured the spots each night (see lithograph).

The same swift movement eastwards upon the planet (from east to west observed from the Earth) as that noticed in regard

to the bright patches, at once became evident. The most conspicuous spot of the group was on the central meridian at $7^h\ 31^m$ on Oct. 29, *following* the middle of the great red spot by 23^m. On Nov. 2 the positions were reversed. The smaller spot preceded the red cloud by 55^m. The next night, Nov. 3, the difference had increased to $1^h\ 7^m$, and on Nov. 4 to $1^h\ 23^m$. On Nov. 8 the interval had further increased to nearly $2\frac{1}{2}^h$, and by Nov. 23, to $7^h\ 26^m$.

The relative observed times were:—

	Great spot in S. hem.	Small spot in N. hem.
	h m	h m
Oct. 29	7 8	7 31
Nov. 2	10 26	9 31
3	6 12	5 5
4	12 4	10 41
8	5 21	12 37

In the latter comparison the *preceding* transit of the red spot has been given because the one following occurred when *Jupiter* was very near the horizon and could not be observed. From an analysis of the estimated times these small spots had an observed period slightly exceeding $9^h\ 48^m$, and $7\frac{1}{2}^m$ less than the red spot.

As opposed to these motions I may remark that there is a small elliptical dark spot s.p. the red cloud which has maintained, since its first discovery by Mr. Barnard at Nashville, Tenn., on July 25 last, a permanent position with reference to the red spot, and therefore evidently partakes of the same character.

Ashley Down, Bristol,
1880, *November* 25.

Observations of the Red Spot on Jupiter. By Ankitam Venhata Nursinga Row.

Mr. Nursinga Row writes from Vizagapatam, India, on Jan. 22, 1880:—I have been observing a reddish brown spot crossing *Jupiter's* disk, every second evening from Dec. 27th. It has always an elongated oval form with a sharp point at the western end of its major axis. It is surrounded by an elliptical ring of brilliant white with a yellow tinge on its outer edge, which is brightest when the spot is on the central meridian of the planet.

The longer axis of the elliptic ring is about equal to one-third of the planet's diameter. On the 29th of Dec. I estimated that it crossed the central meridian at $6^h\ 23^m\ 27^s$ P.M., and on the 31st it crossed the central meridian at $7^h\ 58^m\ 15^s$ P.M.

A six-inch achromatic telescope has been employed in making the above observations with an eyepiece giving a power of 150.

Note on a Phenomenon of Jupiter's Satellites. By Capt. W. Noble.

On turning the telescope on to *Jupiter* at 8^h 30^m L.M.T. on the night of October 18, I noticed, of course, the shadows of the two Satellites which were at that moment crossing the planet's disk. So peculiar an appearance, however, did the preceding one present (that, as I immediately subsequently ascertained, of Satellite II.) that I turned to the *Nautical Almanac* before I could satisfy myself that it was a shadow at all. It was, naturally, smaller than that of Satellite I., which was about a quarter of the way across *Jupiter's* face, and just skirting the south equatorial belt; but what at once arrested my attention was its curiously light colour. In fact, it looked lighter than I have seen Satellite III. itself look while in the act of transiting its primary; and this at first impressed me with the idea that I was really looking at a Satellite, and not at its shadow at all, until reference to the Ephemeris convinced me to the contrary. Briefly then the shadow of Satellite II. appeared like a very small circular spot of a dark brown tint, while that of Satellite I. resembled a tiny disk of ink. The only feasible or conceivable explanation of this curious phenomenon, to me, is this—that while obviously the portions of the planet's disk covered by these shadows suffered a total solar eclipse, the shadow of Satellite II. must have fallen upon a part of it more than ordinarily self-luminous. As a matter of fact it was considerably south of the equator, and in a different zone to that of Satellite I. Power, 154, on my 4·2-inch Ross Equatoreal.

Forest Lodge, Macesfield, Uckfield,
1880, *October* 22.

Note on a Photograph of Jupiter. By A. A. Common, Esq.

On August 9, 1880, a transit of the shadow of the III. Satellite taking place, I took some photographs of the planet, one of which I herewith present to the Society. It was taken at 11 42, G. M. T. and shows *Jupiter* with the bands, the II. and III. Satellites and the shadow of the III. on the disk. The exposure for the planet was about two seconds, for the Satellites twenty seconds. Some photographs have been taken of the red spot, and they are very similar to those taken last year.

Ealing,
November, 1880.

Note on the Nebulæ near Merope. By A. A. Common, Esq.

In the Supplementary Number of the *Notices* of this Society for 1880, there is an extract of a letter from Professor Tempel in which he states that I have evidently made the sketch published in the April Number with a telescope of insufficient power to show the *Merope* Nebula. Perhaps I ought to have stated that the telescope was of three feet *aperture*, but the mention of the fact that the stars on the sketch were pricked off from a photograph taken by the same telescope ought to have shown that it was of ample power. I drew attention to the fact that the patch of light near *Alcyone* was seen but once, but that the smaller patch was always seen as a detached portion. By the aid of a sketch which includes the small stars near, I am enabled to locate the Nebula on the map that Prof. Tempel gives. On this sketch are four small stars nearly at equal distances apart pointing to *Alcyone*, with three others that form with the four an acute triangle with *Merope* for the apex. Now the exact position of this detached Nebula from the sketch I made on February 29, 1880, is this: it commences at the faint star near *Merope* and passes over the three stars already mentioned, the major axis nearly corresponding to the line made by these three faint stars. In my sketch, two faint stars are also shown, and another faint one between the edge of the Nebula and *Merope*, the sky here being quite black—making this a distinct Nebula from that on the other side of *Merope*.

Ealing,
1880, *November* 11.

A New Nebula. By J. Baxendell, Esq.

(*From a letter to W. H. M. Christie, Esq.*)

On the night of September 28, 1880, I observed a large but faint Nebula which is new to me, and which I do not find entered in any Catalogue or marked on any map I have in my possession. It is in *Aquarius*, near to and north of the fine cluster Messier's No. 2, its southern boundary, so far as I have yet made it out, being only about 7′ distant from the cluster. It has an irregular oval form, its longer axis lying in a nearly east and west direction. A mean of several estimations gives its length about $1\frac{1}{4}°$, and its breadth about 52′. It seems to be similar in character to the large Nebula near the *Pleiades*, but is slightly less bright. I have, however, seen it on several nights, and have no doubt of its existence.

The Observatory, Birkdale,
1880, *Nov.* 1.

Cometary Observations made at the University Observatory, Oxford. By the Rev. Prof. C. Pritchard.

Hartwig's Comet

Date 1880.	Oxford Mean Time. h m s	$\delta - *$ $\Delta\alpha$ ′ ″	Apparent R. A. of δ. h m s	Oxford Mean Time. h m s	$\delta - *$ $\Delta\delta$ ′ ″	Apparent Declination of δ. ° ′ ″	Star of Comparison.
Oct. 5	9 20 40·9	+ 8·16	15 54 36·88	9 22 23·0	−11 57·7	+25 34 36·8	*a*
11	7 21 56·5	+1 58·48		7 21 56·5	− 1 4·9		
11	7 44 44·4	+1 3·42		7 44 44·4	+ 1 10·1		
14	7 1 29·6	+ 22·93	17 15 26·74	7 1 40·4	− 5 4·1	+18 5 59·2	*b*
18	7 50 16·4	−3 28·16	17 36 11·79	7 50 16·4	+ 3 26·7	+15 37 26·7	*c*
20	6 54 17·8	−2 6·24	17 44 22·89	6 54 17·8	+ 9·0	+14 36 36·5	*d*
23	8 55 4·0	+4 17·18	17 55 25·55	8 57 9·5	+ 7 41·7	+13 15 28·7	*e*
30	6 56 45·3	−3 55·19	18 14 38·51	7 14 59·3	− 4 27·7	+10 49 25·7	*f*
31	6 22 19·9	+ 1·98	18 16 52·89	6 23 32·7	+ 2 49·4	+10 33 20·0	*g*
Nov. 2	6 54 48·5	+ 32·22	18 21 24·26	6 32 59·5	+ 3 5·1	+10 2 6·6	*h*
2	6 54 48·5	+ 22·24	18 21 24·20	6 32 59·5	+ 8·6	+10 2 5·8	*i*
3	6 35 24·9	−1 0·42	18 23 28·77	6 49 17·4	+ 2 3·8	+ 9 47 30·9	*j*
4	6 43 50·1	−2 38·26	18 25 31·45	6 43 50·1	+ 5 43·9	+ 9 33 54·7	*k*

Adopted Mean Places of Comparison Stars, 1880·0.

	R. A.			Declination.			
	h	m	s	°	′	″	
a	15	54	27·02	+25	46	31·9	Taylor 8338,
b	17	15	1·63	+18	10	56·1	Rumker 5777 and Taylor 8033,
c	17	39	37·67	+15	33	51·3	Bonn Catalogue + 15° No. 3263,
d	17	46	26·80	+14	36	18·5	Weisse Bessel xvii^{h} No. 920,
e	17	51	6·01	+13	7	36·9	Weisse Bessel xvii^{h} No. 1022,
f	18	18	31·23	+10	53	42·5	Weisse Bessel xviii^{h} No. 392,
g	18	16	48·85	+10	30	21·1	Micrometrically connected with Bonn Cat. + 10° No. 3488,
h	18	20	49·57	+ 9	58	50·7	Weisse Bessel xviii^{h} No. 452,
i	18	20	59·49	+10	1	46·4	Weisse Bessel xviii^{h} No. 458,
j	18	24	26·70	+ 9	45	15·8	Bonn Catalogue + 9° No. 3741,
k	18	28	7·23	+ 9	27	55·8	Bonn Catalogue + 9° No. 3771.

Remarks :—Oct. 5. The Comet was rather low when found, and no trace of a tail was visible.

Oct. 14. Bright moonlight and sky foggy : the Comet is now a very inconspicuous object and not seen in a telescope of 4″ aperture.

Oct. 18. The Moon now nearly full and the Comet very faint.

Oct. 30. The Comet, which on this night was very indistinct from fog, was also compared with Weisse Bessel, xviii. No. 383, but this is apparently an error in the right ascension as given by Bessel.

Oct. 31. The sky having clouded suddenly : only one measure of difference of right ascension and of declination could be obtained.

Nov. 4. Sky foggy : observation very uncertain.

Faye's Comet.

Date 1880.	Oxford Mean Time.	$\delta - \alpha$ $d\alpha$.	Geocentric R.A. of δ.	Oxford Mean Time.	$\delta - *$ $d\Delta$.	Geocentric Declination of δ.	Correction to Ephemeris. $d\alpha$.	Correction to Ephemeris. $d\Delta$.	Star of Comparison.
	h m s	m s	h m s	h m s	′ ″	° ′ ″	s	″	
Sept. 6	10 28 13·4	−1 3·60	23 4 7·90	10 28 13·4	− 28″·4	+9 17 57″·6	−2·17	+ 5·5	*a*
28	10 27 22·6	−1 53·23	22 51 16·44	10 27 22·6	+7 24·0	+5 38 25·9	−2·08	+19·7	*b*
Oct. 2	8 57 48·7	− 54·30	22 49 38·91	9 19 51·7	−1 6·2	+4 52 18·5	−2·04	− 3·9	*c*
5	10 5 50·0	− 45·08	22 48 39·65	10 14 26·5	+5 0·8	+4 16 24·1	−1·42	+ 5·0	*d*
11	10 3 42·6	+ 23·07		10 3 42·6	+4 5·3				
30	8 20 8·5	− 18·89	22 51 34·02	8 12 53·8	+2 27·9	−0 0 22·8	−1·29	+ 6·9	*e*
Nov. 2	7 27 15·4	−1 12·53	22 53 20·15	7 35 29·8	+4 14·6	−0 22 39·8	−2·19	+ 2·1	*f*
3	7 13 30·9	− 32·36	22 54 0·32	7 28 6·7	−2 43·4	−0 29 37·6	−1·95	+ 1·5	*f*
4	7 31 48·0	− 34·38	22 54 43·87	7 44 58·2	−5 40·6	−0 36 27·0	−1·34	+ 1·4	*g*

Adopted Mean Places of Comparison Stars, 1880·0.

	R. A.			Declination.			
	h	m	s	°	′	″	
a	23	5	7·21	+9	17	53·1	Micrometrically connected with Rumker 10913,
b	22	53	5·23	+5	30	26·6	Bonn Catalogue +5° No. 5114,
c	22	50	28·89	+4	52	49·4	Bonn Catalogue +4° No. 4927,
d	22	49	20·28	+4	10	48·0	Weisse Bessel xxii^{h} No. 1000,
e	22	51	48·70	+0	1	30·8	Micrometrically connected with W. B. xxii^{h} No. 1192,
f	22	54	28·52	−0	27	28·6	Gr. 12 yr. Cat. No. 2067, and Armagh No. 5066,
g	22	55	14·08	−0	31	20·9	Weisse Bessel xxii^{h} No. 1132.

The observations have been reduced and the comparisons with the Ephemeris have been made with the necessary corrections. This Comet has been so faint during its present apparition that the observations have been made with considerable difficulty. In moonlight it has been impossible to see it with the 12¼-inch Refractor, and from this cause, together with cloudy weather, it has not been observed since the 4th inst. The observations were made, under my direction, by Mr. W. Plummer.

Oxford,
1880, *November* 11.

On the Spectrum of Comet 1880 *d* (*Hartwig's*).

By W. H. M. Christie, Esq.

Cloudy weather prevented any observation of this comet at the Royal Observatory, Greenwich, till October 7, by which time it had considerably diminished in brightness. I observed the spectrum with the single prism spectroscope on the Great Equatoreal on October 7, 11, and 12, and found that it consisted of the three usual cometary bands, the nucleus giving a continuous spectrum.

Measures of the position of the brightest band as compared with the green carbon-band at 5198 (alcohol in a vacuum-tube) on Oct. 7 and 12, and with that at 5165 (blue base of flame) on Oct. 11 and 12, were made with the following results:—

1880	G.M.T. h	m	Comet-band.	Wave-length inferred.	Width of Slit.
					in.
Oct. 7	9	0	Red Edge	5198−13 = 5185	0·018 = 35 tenth-metres
	9	0	Red Edge	5198+15 = 5213	
	9	0	Red Edge	5198+ 6 = 5204	
Oct. 11	9	0	Centre	5165−22 = 5143	0·0195 = 38 tenth-metres
	9	20	Centre	5165+36 = 5201	
Oct. 12	7	30	Centre	5198+ 7 = 5205	0·0165 = 32 tenth-metres
	8	0	Centre	5198−44 = 5154	
	8	20	Centre	5198−50 = 5148	
	„		„	5165− 2 = 5163	

MEANS--

		in.
Oct. 7	5201	0·018 = 35 tenth-metres
Oct 11 and 12	5169	0·018 = 35 tenth-metres

The less refrangible edges of the comet-band and carbon-band were compared on Oct. 7, and the centres of the brightest part of the two bands on Oct. 11 and 12.

These measures leave it uncertain whether the comet-band coincides with the band in the second spectrum of carbon (vacuum-tube) at 5198, or with that in the first spectrum (blue flame of Bunsen burner) at 5165. The measures on Oct. 7 were more satisfactory than those on Oct. 11 and 12, and are entitled to more confidence, both the comet-band and the carbon-band being much brighter. On Oct. 12 the carbon-band from the vacuum-tube (which was an old one) was hardly visible, being overpowered by the complex or band-spectrum of hydrogen which had, in course of time, replaced the ordinary hydrogen spectrum of four lines. The measures of the carbon-band were thus little more than guesses on this day. In the comparisons with the flame spectrum, it was difficult to avoid parallax, the slit being wide and the flame blown about by the wind.

The real difficulty in the determination of the exact position of the comet-band arises from the width of the slit, which is necessarily considerable. As far as these observations go, they would seem to show that different results are obtained according as the edge or the centre of the band in each spectrum is compared; and it is not easy to say which is correct, since the band (with a narrow slit) is sharp on the red side and fades off towards the blue. Further observations, however, are wanted to decide whether there is a real discordance as here indicated.

No measures could be made of the two other comet-bands. The band in the blue was only seen on Oct. 7, and Mr. Maunder then estimated that the band in the green was at least five times as bright as the two others.

Royal Observatory, Greenwich,
1880, *November* 10.

The July Aquariads 1880. By Edwin F. Sawyer, Esq.

The region situated within the boundary of the constellation *Aquarius* appears to offer attractions of more than ordinary interest to the meteor observer during the months of July and August, and especially at the end of the former month; an inspection of the Catalogues of various observers showing that many meteor tracks have been registered at this epoch, radiating from several quite well defined and apparently independent meteor streams centred in this constellation. Dr. Schmidt's observations of these meteors certainly extend back to the year 1849, for on July 28th and 29th of that year he found a position at R.A. $322°{\cdot}5 - 5°$, and his Catalogue, based on observations made between the years 1842 and 1868, contains no less than nine independent positions deduced during this epoch and situated in this region.

These meteors have also been frequently observed by Heis, Tupman, Neumayer, Weiss, Denning, Corder, and others. Mr. Denning found these Aquariads especially numerous at the end of July, in the years 1878 and 1879, furnishing meteor showers of considerable intensity (see the valuable paper by Mr. Denning in these *Notices*, vol. xl. No. 3).

My attention having been particularly directed to these meteors by this paper, a series of observations was arranged and quite successfully carried out by me this year. Watches were maintained on the evenings of July 28, 29, 30, 31, and August 1, and these Aquariads were found to be quite numerous, especially on the 29th and 30th.

The following table shows the number of hours spent in watching, and the number of meteors recorded :—

Date 1880.	Duration of Watch. h.	Length of Watch. h.	No. of Meteors seen.	Aquariads.	State of Sky, &c.
July 28	9 to 12	3	14	6	Clear; moon after 11·15 p.m. troublesome; meteors scarce. Hazy at times and partly cloudy.
„ 29	9 „ 12	3	30	11	Meteors numerous.
„ 30	9 „ 12	3	36	11	Generally very clear, with the exception of a slight haze after 11.30. Meteors numerous.
„ 31	9 „ 11	2	10	2	Generally hazy.
Aug. 1	9 „ 11	2	12	2	Quite clear.
July 28–Aug. 1	9 „ 12	13	102	32	

Of the different magnitudes of brightness there were observed the following :—

= ♃	> 1st mag.	✶ = 1st mag.	= 2nd mag.	= 3rd mag.	= 4th mag.	= 5th mag. and fainter.	Total.
2	5	18	13	18	19	27	= 102

On reducing the observations I was very much surprised to find that, instead of one radiant-centre furnishing the meteors from this constellation, there were at least three independent positions shown to exist; and the chief display was from a position at R.A. 330°—6°, this centre being quite accurately determined from several short paths near the focus, and giving a good radiation. Of the 32 Aquariads recorded 20 belonged to this stream. The shower R.A. 341°—13°, as deduced by Mr. Denning, and found by him to furnish the chief display, appeared quite inactive this year, although the position was feebly indicated by four short paths, and giving the centre as at R.A. 341°—10°. The third position was found to lie at R.A. 328°—15°, and was well determined from several very short paths accurately recorded near the focus. Eight paths altogether were recorded belonging to this position. The meteors from the chief radiant at 330°—6° were generally quite slow, of medium length and very bright, and from the other positions generally fainter and more rapid.

In looking over the various Catalogues accessible to me, several positions were found which appear to fully corroborate my results, the agreement in the majority of cases being quite close.

These positions together with mine are given below for comparison.

1st.

Denning,	July 16–25,	1876 =	R.A.	337°– 7°
„	„ 6–17	1877 =	„	336– 7
Heis	Aug. 21	1877 =	„	336– 5
Sawyer	„ 28	1880 =	„	330– 6
Corder	„ 29–30	1880 =	„	331–10
		Average =	R.A.	334– 7

2nd.

Tupman,	July 27–28,	1870 =	R.A.	340°–14°
Denning	„ 27–29,	1878 =	„	341–13
„	„ 28,	1879 =	„	338–14
Schmidt,	„ 20–31,	=	„	340– 8
Sawyer,	„ 28,	1880 =	„	341–10
Corder,	July and Aug.	=	„	337–13
		Average =	R.A.	340–12

3rd.

Schmidt,	July 20–31,	= R.A.	333°–14°
Tupman,	,, 28,	= ,,	326–13
Sawyer,	,, 28–29. 1880	= ,,	328–15
		Average = R.A.	329–14

These radiants also furnish many meteors during August and would appear to represent long enduring showers.

Cambridgeport, Mass., U.S.A.
1880, *Sept.* 30.

Mr. F. Cooper, in a letter dated Sheffield, Sept. 27, 1880, records an Outbreak on the Sun's surface, seen by him on Saturday August 14, while examining sun-spots with a power of 85 on a three-inch refractor, four feet focal length: at about $4^h\ 15^m$, G. M. T., he was scrutinising a small spot at the southern end of the group when suddenly, at an apparent distance of 10″ following, an intensely bright spot burst out, vanishing again before he had time to change the power. The colour of the Outbreak was a deep chrome yellow. He had no time to measure the diameter, but it was apparently about 3″. The coloured glass was a neutral tint. The Outbreak was much brighter than the Sun's disk, and the brighter and more deeply coloured of the faculæ, of which much was observable. At the time of observation the air was clear and still, no boiling, definition very good, the mottled appearance well and sharply defined generally over the Sun's surface. He inquires whether the phenomenon was seen by any other observer; or could it be merely an optical delusion?

As regards the magnetic condition at the time, Mr. Ellis writes that at Greenwich an active magnetic disturbance commenced 1880, Aug. 10, $22^h\ 30^m$, and continued till Aug. 11, 12^h. The magnets were quiet to Aug. 12, 0^h, and then very much disturbed till Aug. 12, 18^h; tolerably quiet till Aug. 13, 4^h, and then disturbed till Aug. 13, 18^h; afterwards and during Aug. 14 all pretty quiet; very little motion then till Aug. 18. Previous to Aug. 10, the magnets had been tolerably quiet.

Mr. Cromwell F. Varley, in a letter dated 2 Great Winchester Street, Nov. 5, 1880 (accompanied by a sketch), gives an account of an unusually fine Meteor seen by him the preceding night, $3\frac{1}{2}$ minutes to 10^h or $10^h\ 15^m$ while returning home to Bexley Heath, $11\frac{3}{4}$ miles E. on the main road. The meteor lasted one to one and a half seconds, being at its brightest more than 12 times as bright as *Jupiter*, and it suddenly disappeared near *β Orionis* (Rigel), leaving a brilliant green train which lasted from five to six seconds; the colour and brilliancy of this train resembled the voltaic arc taken between silver electrodes.